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BALLOONING ACROSS THE CHANNEL.

An unsuccessful attempt to cross the channel, from the Kentish coast to France, in a balloon, was made on the 4th of March last. The aerial voyagers, Colonel Brine, R.E., and Mr. Joseph Simmons, a professional balloonist, came down into the sea, but were picked up by one of the Calais and Dover steamboats.

They ascended from Canterbury at half-past eleven. If they had started earlier in the day, it is probable that they would have crossed the channel safely in three hours. The passage by a balloon has been frequently made in past years. At half-past eight in the morning the process of inflating the balloon was begun; for which purpose there were pipes laid from the Wincheap gasometer to the balloon, which was placed in an adjoining meadow. The quantity of gas required was 37,000 cubic feet, and this was injected into the huge India-rubber bag in about two hours. When filled, the balloon was allowed to ascend slightly, and the aeronaut proceeded to attach the car and life-saving apparatus, a work which occupied twenty minutes. A supply of provisions was placed in the car, and a couple of boxes, containing carrier pigeons, were affixed to the cordage, it being the intention of the voyagers to set free a couple of the birds when in mid-channel, and another on reaching the French coast.

"We started," says Mr. Simmons, "under conditions so favorable that neither I nor Colonel Brine felt the least misgiving as to the result. After one of the most successful ascents I have ever made, with wind, and light, and everything in our favor, we got fairly away from the town at 11:30. At 11:50 vessels out at sea were in full view, looking like small pilot-balloons in the air, and not appearing to be on the water at all. We could also see the Goodwin Sands, which presented the appearance of soles in the water. At 12 o'clock we had Dover in full view, and heard the noon gun fired from the castle. At 12:1 our course was straight for Folkestone. Our altitude was now 2,100 ft. Up to 12:4 I had not had occasion to touch the valve. At 12:20 we were midway between Dover and Folkestone, or on the western side of both towns."

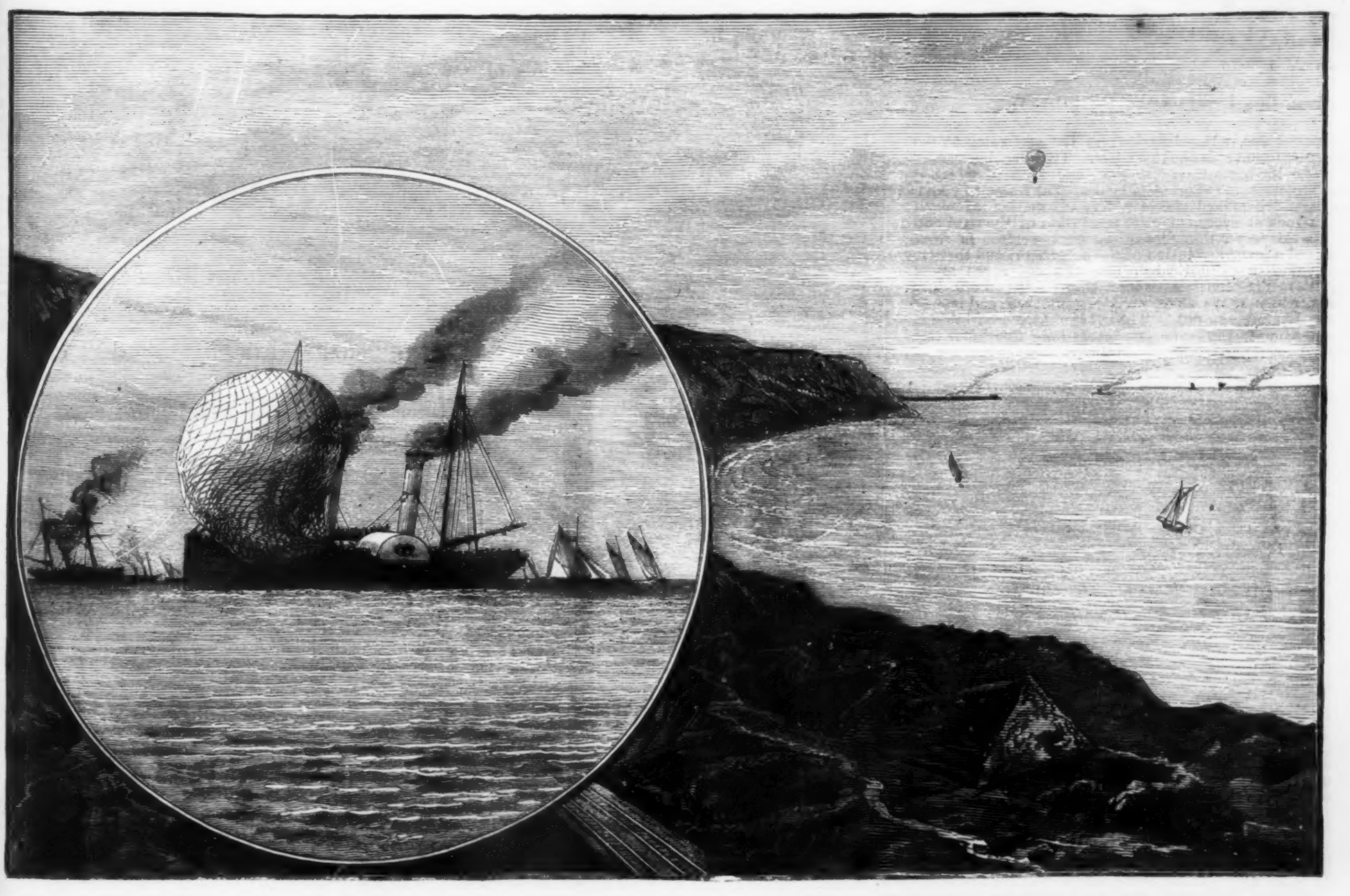
Mr. Simmons then describes what he terms a perfect photograph of the balloon and car seen on a cloud which had surrounded them. "We could see our own reflection (continues Mr. Simmons) and every detail, even to the untying of a knot which I was engaged in doing. It was a perfect portrait. There was at this moment a lovely rainbow surrounding the car—not the balloon—about 10 feet in diameter, and the beauty of the whole scene was strikingly grand. At 12:30 we had gained an altitude of 2,400 feet. At 1:8 we were off the Admiralty Pier, and at 1:10 our altitude above the sea level was only 600 ft. We passed over a three-masted steamer, the crew of which raised a cheer. We were then in the right course for the French coast; but a few minutes afterward I saw the shadow of the balloon in the sea, forming a beautifully colored picture; this indicated to me that the wind was suddenly changing, and I at once perceived that we were going in a southeast direction. Our altitude was now 2,200 ft. I let the balloon take a turn to come down, and endeavored to remain at about 1,200 ft.—that being the elevation which Colonel Brine wished me to keep. With all our maneuvering, however, we found that the currents were bearing from the southwest, and we were swinging round about parallel to the circular form of the coast in this part. No current could be found which would take us to the French coast, nor could we see the coast on the other side, the atmosphere being misty. Colonel Brine repeatedly expressed his opinion that we were drifting toward the North Sea; but as I did not want to give it up until a few more attempts, I made no answer. However, at last I was obliged to confess that we were not going anywhere near Calais, and that if we kept on much longer we should find ourselves making for the German Ocean. This was about 2:10, and on taking another turn downward we sighted the Calais mail packet. We were about mid-channel, and I could tell from the direction of the smoke from the vessel's funnels, that the wind was southwest. This at once determined me to be prompt in action. I directed the Colonel, who was perfectly calm, to put on his cork jacket, which he instantly did. I at first let free a couple of the pigeons—one made straight for home, the other hovered about the car. With our cork jackets on we prepared for striking the water, which we did with great force at 2:32. The mail packet had then gone away from us some two or three miles, and there was not a minute to be lost if we were to be picked up by it. With the car in the water, and our legs completely submerged, we glided slowly on. The passengers on the steamer had apparently watched our movements, and, our difficult position being observed, the vessel immediately put about, reversed its course, and came up to us within a hundred yards. At 2:46, after considerable difficulty, owing to the flapping of the balloon against the vessel, and in keeping back the passengers so that they might avoid being suffocated by the tremendous rush of gas which I was letting out all the time, we were rescued from our perilous situation, and having, at 3:15, got the balloon on board, were brought into Dover, landing at the Admiralty Pier, where we were greeted with cheers from thousands of people."—*Illustrated London News.*

THE RAILWAY TUNNEL BETWEEN FRANCE AND ENGLAND.

Projects for a tunnel under the English Channel, which have engaged the attention of engineers for several years, have seemed to the general public chimerical, not only because of the numerous difficulties involved in the execution of such a work, but also because of the enormous sum of money that it would cost. Nevertheless, the work has finally been begun and is rapidly progressing, and, unless an unforeseen accident supervenes, the completion of this great enterprise may be looked forward to as occurring at no very distant date. The operations on the English coast have been intrusted to the Submarine Continental Railway Company.

The region in which the shaft has been sunk by the latter is traversed by travelers on their way from Folkestone to Dover. Not far from the last-named town, and at some few feet west of the entrance to the tunnel under Shakespeare's Cliff, there may be seen from the car windows, between the railway and the shore, the structures which shelter the steam engines and other apparatus. In one of these structures there are three powerful horizontal engines, two of which are employed in compressing air for the use of the workmen under ground. The other engine serves for actuating a windlass for ascent and descent in the shaft, and, at the same time, furnishes the motive power necessary to actuate the electric machines that send the current to the lamps installed in the galleries. In external aspect the shaft is very similar to those of coal and other mines. The cut on next page gives a perspective view of it. The lowering apparatus consists of an iron basket large enough to hold five or six persons, and which is maneuvered by one of the steam engines, as above stated. The diameter of the shaft is about 10 feet and its depth about 150, the bottom being at least 90 feet beneath the level of the lowest tides. There is but little infiltration of water through the fissures in the planking to be perceived, yet the atmosphere is very moist, and quickly impregnates everything coming in from outside. In the galleries, everything up to the present is much drier. Coming to the lower part of the shaft, we find a square chamber excavated out of the gray marl, whose walls are protected by heavy planks. From this chamber starts the experimental gallery, which is 7½ feet in diameter, and becomes more spacious here and there in the distance. In one of these spaces the Company recently gave a reception and collation to the principal directors and fifty members of the press. The scene on that occasion is depicted in Fig. 4.

The electric light has necessarily played an important



Rescue of the Balloon by the Calais Packet, as seen through a telescope. View of the Balloon as it left the land.

BALLOON VOYAGE ACROSS THE CHANNEL, FROM ENGLAND TO FRANCE.

rôle in this enterprise. Mr. Lewis Nebel, the electrician of the Siemens Company, who directs this part of the work, had already put in forty-eight Swan lamps up to end of last month. These lamps, which are supplied by Siemens machines, are arranged in the galleries in series of six, alternately; and each series is mounted for quantity between the two conducting cables. Opinion is unanimous as to the excellent effect produced by this lighting. In Fig. 3 we give a sketch showing the aspect of the gallery in which is being executed at present the work of tunneling by the aid of the Swan light. Purely incandescent lamps possess, as is well known, the great advantage of producing no effect on the respirable air which is forced into the galleries; so, in measure as the work proceeds, arrangements are made to increase their number.

The work of tunneling is executed by means of a Beaumont perforator, whose length from the perforator to the opposite extremity is about 35 feet. The machine carries two arms having a rotary motion, and each of which is provided with seven short steel blades. The frame to which these parts are affixed makes a forward motion of about half an inch at every complete revolution of the steel cutters. In this way a thin slice of the whole surface in front is removed at ever revolution of the perforator, and there is thus obtained a cylindrical opening of about seven and a half feet in diameter. A laborer shovels the *debris* into buckets, which move along on a metallic belt and empty into a car running on rails. The car is shoved by workmen to the opening in the shaft; but before long this labor will be done by compressed air.

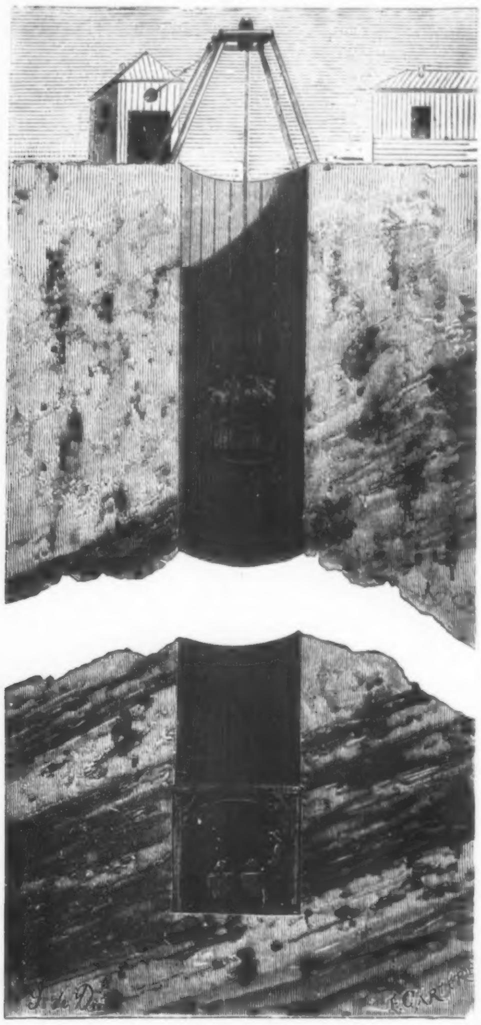


FIG. 1.—SECTION OF SHAFT.

The excavating apparatus is making a forward progress at present of about three hundred and ten feet per week; but Col. Beaumont sees no difficulty in causing it to advance at the rate of at least four inches per revolution and making it revolve five times per minute, thus effecting a much more rapid progress.

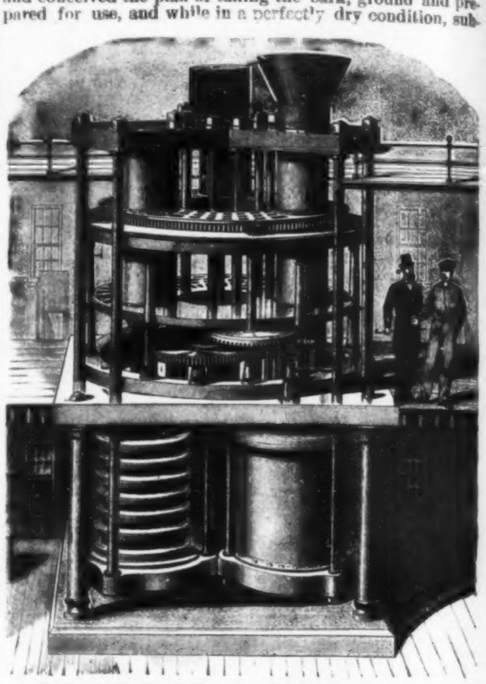
The density of the marly bed in which the work in England is now being performed has been compared to that of Stilton cheese, and it appears that the *debris* removed can be made into an excellent cement, which will serve for coating the interior of the tunnel. The final diameter is to be 13½ feet. If the work on the French side is pushed with the same rapidity as that on the English, it is estimated that the whole may be completed in the space of three and a half years. Beginning with the lower level of the shaft, slightly inclined galleries will be excavated, so as to reach the railways now in operation on the surface. It is calculated that this can be done without having recourse to very steep grades. If the cars which are to run from one shore to the other are driven by compressed air engines, the latter will at the same time serve to increase the quantity of respirable air necessary to travelers; but it is very probable that electricity will be preferred for traction, and that the renewal of the air will be secured by the use of powerful compression engines.

It is useless to dwell upon the immense advantages that are to accrue to the two countries from this tunnel. It now takes nine, ten, or eleven hours to cross the Straits of Dover, but after the completion of this great undertaking it will be possible to make the trip from Paris to London in five hours.

TAN-BARK PRESSING MACHINE.

HITHERTO one of the great drawbacks to the leather manufacturing industry has been the great difficulty experienced in getting the necessary bark in those districts distant from the forests which were the natural sources of supply of this necessary material. As the country has been settled and cleared up this source has been constantly decreasing, and removed further and further from the points of most extensive consumption. The extreme bulkiness of the bark in its natural state making it impossible to pack more than two or three tons to the car-load has rendered its transportation to great distances almost an impossibility, and the consequence has been, says the *Western Manufacturer*, that the industry has suffered from the expense and almost impossibility of manufacturers to secure their supplies of the material. Attempts have been made to remedy the difficulty by a chemical distillation of the bark, and the "hemlock extract" has been used to some extent, but it has never proved a real success, as the extract has not answered the purpose as well as the ground bark itself.

Some time since, Mr. C. Kimplen, a practical mechanical inventor, of Chicago, took the matter into consideration, and conceived the plan of taking the bark, ground and prepared for use, and while in a perfectly dry condition, subjecting it to an enormous pressure, and thus forming it into blocks or other forms most convenient for transportation. The object was to put the ground bark into the least possible space without expressing or losing any of the tannic



IMPROVED TAN-BARK PRESSING MACHINE.

THE CHANNEL TUNNEL.—FIG. 2.—ENTRANCE TO THE SHAFT NEAR SHAKESPEARE'S CLIFF.

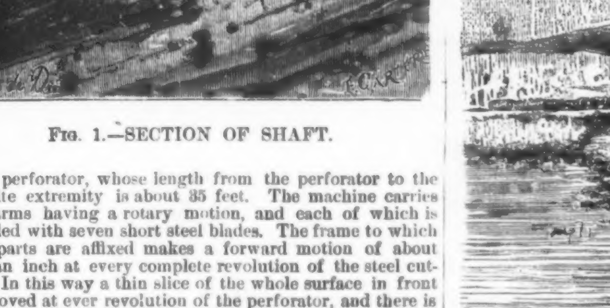


FIG. 3.—OPERATION OF THE BEAUMONT EXCAVATOR.

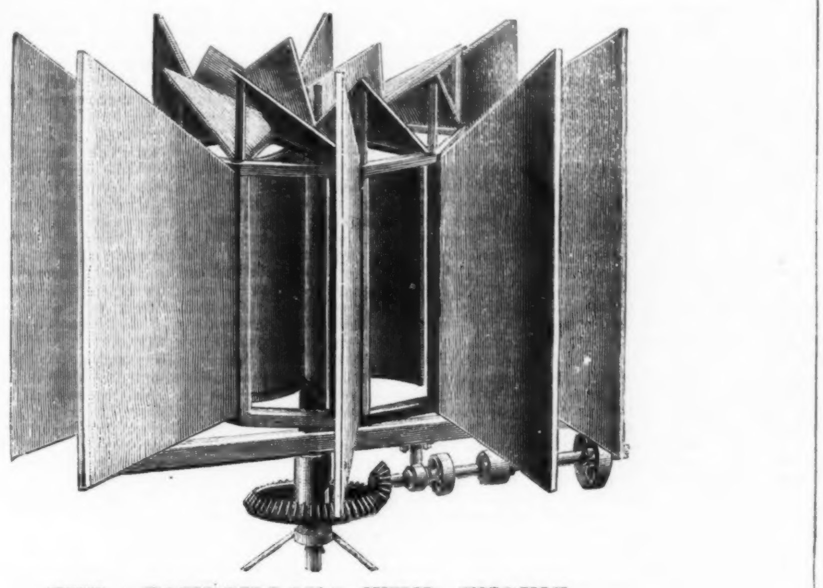
FIG. 4.—RECEPTION IN THE TUNNEL.

THE RAILWAY TUNNEL UNDER THE ENGLISH CHANNEL, BETWEEN ENGLAND AND FRANCE.

ingredients. To make practical his conception he invented and patented a machine for pressing the ground bark, of immense power, an illustration of which we furnish opposite. The machine is essentially a hydrostatic press, especially adapted to the material to be acted upon. The upper portion of the machine, as shown in the cut, consists of three upright cylinders set in a revolving frame, so that while one is receiving the ground bark, fed from the funnel-shaped hopper shown at the right, the second may be receiving its pressure from the machinery below, and the third is delivering the cylindrical pressed block of bark, as shown at the left of the hopper. The bark comes from the press a solid block, almost of the weight of iron, and may be handled for transportation without danger of disintegration, and yet possessing all the quality of the original ground bark. In this condition large quantities of the bark may be transported to distant localities with no greater bulk than ordinary freight. The introduction of this machine is destined to work a revolution in the leather manufacturing industry, making its prosecution profitable in localities where it has hitherto been almost excluded on account of the impossibility of obtaining the tanning material at reasonable rates.

THE "TOURBILLON" WIND MOTOR.

The wind motor shown in the accompanying cut differs from all other similar apparatus in the fact that it is not necessary to regulate it according to the direction in which the wind is blowing. On the contrary, its object is to direct the wind, from whatever quarter it may proceed, in such a way that it may be utilized. The inventor, Mr. L. Purper, as his starting point, assumes that all winds may be considered as blowing in eight different directions, which are given by the four cardinal points of the compass and the four intermediate positions of the needle. This admitted, he arranges at least eight wind-screens in the direction of the prolonged radii of an octagon, the effect of which is to concentrate the force of the wind; to ward off those extreme parts of the current which might produce a counter pressure prejudicial to the motion of the movable parts; and to cause them to concur in giving an effective result. In the center of the space left free by the screens revolves a vertical shaft, which carries four, six, or eight frames, on which is stretched (not too tightly) canvas in such a way as to cause them to utilize in the best manner possible the wind directed by the screens. Beneath the sails, the axle is guided by the bolster on which it revolves. The cut shows how the upper part is arranged so as to carry the wind, by means of the inclined pieces, against the sails, and thus increase its effectiveness. The directing wind-screens should be of course, as large as possible, and the more so in proportion as their number is smaller. The power transmitted depends upon the surface and weight of the sails, and especially on their breadth. As well known, a goodly number of elements intervene in the performance of wind motors. It is not necessary to select a very elevated place to set this motor up in, provided the locality is not too near buildings. It may be located, as well as anywhere else, on the roof of a house. According to Mr. Purper, when, in calm or nearly calm weather, the sails are caused to revolve by means of a winch, the "Tourbillon" (as he terms his machine) gives rise to currents whose effect, being added to the initial stress, increases it in a large proportion.



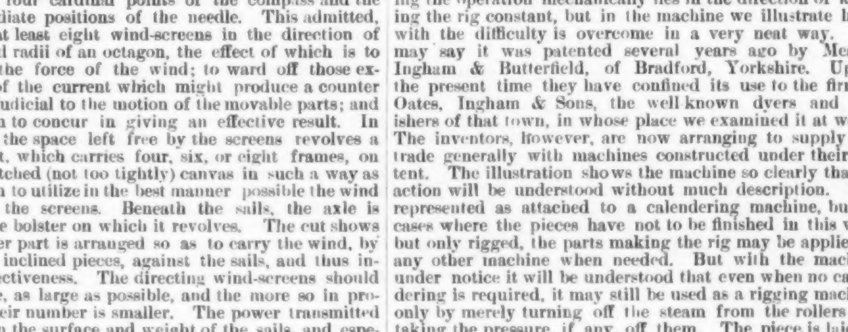
THE "TOURBILLON" WIND ENGINE.

The first model of this apparatus was experimented with at the Frankfort Exhibition, where it actuated simultaneously a pump, a thrashing machine, and a mill.

The sails of this motor are 5 meters in length by 4 in width. The weight of the movable frame is 1,900 kilogrammes, but, as it is perfectly balanced, it revolves with the least wind.

IMPROVED RIGGING MACHINE.

As most of our readers know the operation of rigging is merely the folding of a piece up its center so as to reduce it to half the width for convenience of packing and handling. Sometimes the cloth finisher is ordered to put in a false rig—that is, to fold the piece not exactly up the middle, but a little to one side. The piece in this manner is rigged to more than half its width, and when the purchaser assumes it is exactly half the width he is naturally led to believe that the piece is wider than it actually is. But this is only a point by the way. In any case, whether a true or false rig is given, it is important that it should be the same all along the piece. If a true rig, the selvages should be exactly together, and the fold precisely along the middle. If a false rig is to be given, say, the one selvage is overlapping the other half an inch, apparently increasing the full width by half an inch or any other distance required, which should be the same throughout, and not increase or diminish at various parts of the piece. The difficulty of performing the operation mechanically lies in the direction of keeping the rig constant, but in the machine we illustrate herewith the difficulty is overcome in a very neat way. We may say it was patented several years ago by Messrs. Ingham & Butterfield, of Bradford, Yorkshire. Up to the present time they have confined its use to the firm of Oates, Ingham & Sons, the well known dyers and finishers of that town, in whose place we examined it at work. The inventors, however, are now arranging to supply the trade generally with machines constructed under their patent. The illustration shows the machine so clearly that its action will be understood without much description. It is represented as attached to a calendering machine, but in cases where the pieces have not to be finished in this way, but only rigged, the parts making the rig may be applied to any other machine when needed. But with the machine under notice it will be understood that even when no calendering is required, it may still be used as a rigging machine only by merely turning off the steam from the rollers and taking the pressure, if any, off them. The piece is laid on the floor below, and taking the course shown, is doubled through the inclined and vertical rollers. In order to bring the selvages exactly together, each is passed through an arrangement in duplicate somewhat resembling a loom temple. These are carried by the round bars seen immediately in front of the calender rollers. By adjusting them the rig may be, as required, made exactly true or false to any extent. The fold in the middle is pressed out by a blade weighted with a spring. The arrangement seemed to us to be an efficient one for its purpose, and when we inspected it it was working very satisfactorily, the rig once adjusted keeping itself right without any attention from the operative.—*Textile Manufacturer.*



IMPROVED RIGGING MACHINE.

NEW STIVE ROOM.

In the discussion on the report to the Home Secretary on the Macclesfield flour mill explosion, read at the meeting of the National Association of British and Irish Millers on the 13th of February, 1882, Mr. Stansfield referred to a stive room which was being erected by his firm for the dust which was blown from the stones and rollers in the mill.

Among the advantages claimed for this dust room are: 1. All the air must pass through cloth, canvas, or bunting. 2. An arrangement in which the largest area of canvas is placed in the least space. 3. An arrangement in which the wind in its course over the canvas travels downward, so that the dust dropping off the canvas is not driven up again by the incoming current of air. 4. The least possible amount of woodwork. 5. The least possible cost. 6. Simplicity.

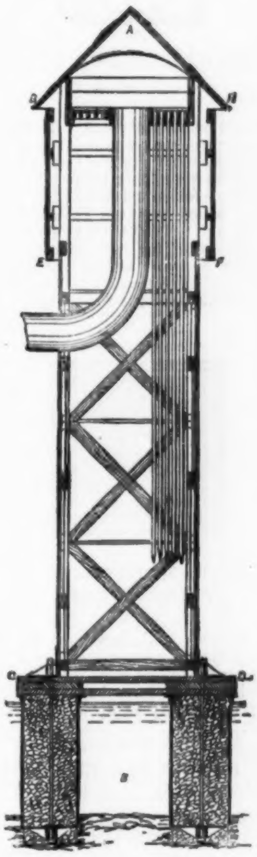


Fig. 1.—SECTIONAL ELEVATION THROUGH A B ON PLANS.

Fig. 1 is a sectional elevation of the new stive room, through the lines A B, on plans, Figs. 2, 3, 4. The room is built some considerable distance from the mill, on the reservoir attached to the latter, and as the water could not be conveniently taken out, four pieces of an old boiler flue were each driven into the bottom of the reservoir and clayed round, the water being subsequently pumped out. Inside the caisson thus formed, 12 inches were excavated from the dam bottom for a solid foundation, and a bolt having been fixed vertically in the center of each tube, as shown in Fig. 1, tubes were filled up with Portland cement concrete, a plate being attached to the bottom. Across the top of the foundation pillars two thicknesses of 11 in. planks were placed, which were covered by 2 in. boards, which are held down by

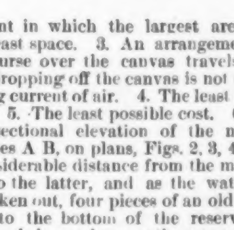


Fig. 2.—PLAN—SECTION THROUGH C D.

four large castings, secured by the bolts already mentioned. The joists of the room are made fast to these castings, to prevent the fabric from being blown over. The room is 6 feet square by 30 feet high at the sides. The framework is substantial, but covered with boarding of only 1 in. thickness, and at the top of the building is the stive box, 6 feet square and 2 feet high. The air from the fan is discharged through a 20 in. pipe, shown in fig. 1, upward into the stive box, through an opening, as shown in Figs. 3, 4. The bottom of the box is composed of lattice work, Fig. 4, with openings 3 inches square and 5½ inch centers. In each of these openings is fixed a canvas or bunting pipe, having a circumference of 12 in., and 7½ yards long, these pipes hanging

down into the room, as shown in Fig. 1, and their lower ends are stopped by tying a loose knot on each. The large opening in the bottom of the stive box is useful as a manhole, in order to get to fasten the pipes in the openings in the lattice work. The area of a pipe 12 in. in circumference and 7½ yards long, is 2½ square yards, which, multiplied by 160 = 400 superficial yards. Only 140 tubes are placed in the stive room, so as to leave an opening on two sides of the pipes, which is convenient for allowing a man to go once or twice a week and shake them a little before or after emptying them. For this purpose an open floor is fixed 8 or 9 feet below the bottom of the stive box, access to which is afforded

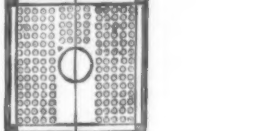


FIG. 3.—PLAN OF CANVAS PIPES—SECTION THROUGH E F.

by a ladder fastened inside the room. In cleaning out the pipes, the man generally shakes them at the top, then opens a few of them at a time and lets the dust out, either into a sack held under, or on to the floor below, the quantity which escapes during the operation being trifling.

The dust room, which receives the air from nine large middlings purifiers and several other machines, and is bolted against the edge of one of the mill buildings, is 7 feet 6 by 8 feet 6 inches inside measure, and 42 feet high. It contains 1,000 superficial feet of canvas, and at one time the stive from the millstones was blown into it. Since the explosion

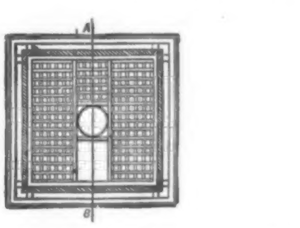


FIG. 4.—PLAN OF LATTICE—SECTION THROUGH G H.

in the Messrs. Fitton's mill, however, Mr. Stansfield resolved to provide a special compartment for the latter; hence the erection of the independent stive room we have described above, and in which means have been provided for the filtration of a very large body of air at comparatively little cost.—*The Miller.*

OIL TANK FIRES FROM LIGHTNING, AND SUGGESTIONS FOR THEIR PREVENTION.

From HENRY MORTON, President of Stevens Institute of Technology.

THE following description of the structure and arrangement of oil tanks in the Pennsylvania region, with an account of the general characteristics of fires occurring in them and suggestions as to their prevention, has been kindly placed at our disposal by President Henry Morton, as containing information likely to interest our general readers:

Iron tanks in the oil regions range in capacity from 2,000 or 3,000 to 3,500 barrels (a barrel is 42 U. S. gallons). Tanks now building are uniformly 3,500 barrels capacity, this being the standard size adopted by the United Lines. They are 93 feet in diameter, and 30 feet high, built of 7 rings; the lower ring is of No. 00 iron, the next of No. 0, next of No. 1, and so on, the top ring being No. 6.

A few of the tanks have plate iron roofs (about No. 12 gauge, riveted and calked), but the great majority have a conical wooden roof, covered with No. 20 iron. There is a practical necessity for this, as the plate iron roofs require a great deal more time to build, and do not continue water-tight after a few months' exposure. Iron roofs, when sunken and covered with water, are especially bad in this last respect, owing to changes in the shape of the shell caused by changes in the temperature, and by filling and emptying the tank. The standard roof is a complete wooden roof (with a pitch of 1½ inches to the foot from the center to throw rain), supported on posts set inside the tank, and covered with No. 20 iron fastened to it by nails, while to the shell of the tank (in order to form an electrical connection) it is securely riveted.

The tank being substantially a big iron pot made of 90 tons of iron, sitting upon about 6,800 square feet of earth, against which it is pressed by the weight of nearly 5,000 tons of oil, would seem to be safe from lightning.* The danger comes from the gas, which rises from the oil, being fired by the electric spark.

The roofs are usually tight enough to prevent the escape of any considerable quantity of gas, even if it was formed rapidly enough to escape in quantity. It is not probable that the firing begins outside the tank, and an escape pipe to carry off the gas would be unnecessary, perhaps dangerous.

If the spark is introduced in the tank amidst the mingled gas and air above the oil, it can only get there by following the pipes, which, running on or in some cases under the surface of the ground, connect the various tanks with each other and with the pumps and the well tanks throughout the country. Of these pipes, every joint of which is more or less directly connected with every other joint, there are several thousand miles, varying in size from two inches to twelve inches in diameter. These pipes are connected with the tanks in either of two ways:

1st. They run up the sides and over the top of the tank, bending into the hatchway; in this case, they are held to the shell of the tank by an iron band fastened to the roof (which makes an electrical connection), but they extend twelve or fifteen inches into the tank through the hatch. Supposing a pipe so arranged to be struck by lightning, it is plain that if its tension was not sufficiently relieved by the earth over or through which it passes, nor by the iron band which held it to the tank, the discharge would take place from the end of the pipe to the side of the tank through the mingled air and gas above the oil, and the tank would be fired.

To provide against this, arrangements are rapidly being made, whereby in all cases where the pipes are required to go over the top (station tanks where oil is being received daily; it is necessary to see the stream coming from the pipe to judge whether the pipe is intact in its whole length) so that the pipes shall not extend through the shell of the tank, but terminate in a flange bolted to the shell.*

2d. But the majority of the tanks are storage tanks, and are not so arranged. Oil is pumped into storage tanks through a pipe which enters near the bottom through a flange bolted to the shell. If the pipe terminated there, it would seem there could be no danger, as the tank would then be simply an expansion or enlargement of the pipe. To provide, however, against the water (which is always present in the oil) settling about the outlet valve, and by freezing, bursting it, the pipe is continued through the shell by what is called a "swing pipe," and which is intended to be constantly above the surface of the oil at its extremity.† In such cases an electric discharge through the pipe might be of sufficient intensity to cause a spark between this extremity and the shell of the tank. Query: Would this be possible if the end of the swing pipe was kept two or three feet below the surface of the oil? Moreover, the swing pipe has to be raised and lowered by an iron chain, one end of which is fastened to the pipe and the other to a windlass placed above one of the hatches in the roof, through which the chain passes. If this windlass was made of iron, and bolted to the roof, could there be a spark?

The only safety for such tanks seems to be to disconnect them entirely from the pipe. But it has been claimed that as the swing pipe extends within a few feet of the roof, in case the tank should be struck direct, there might be a spark from the roof to the pipe. Respecting this connection it may be well to add that while the iron of the bottom (which is pretty light, being No. 6) hugs the earth very closely, yet the great pressure effectually excludes moisture, and the ground beneath the tank is very dry.

One idea of the cause of these fires is that they are owing to the pipe connection; and this is believed, 1st, for the negative reason that no tank entirely disconnected has ever been fired, which is, however, but a poor reason; and, 2d, from the analogy there is between the system of pipes on the ground and the telegraph wires above them. The presence of atmospheric electricity on the wires is made manifest in the offices almost every summer's day. Now, while the wires have the advantage in insulation, and so carry to the telegraph instruments a large percentage of the electricity induced upon or conducted to them, the pipes, to counterbalance their imperfect insulation, have an immensely greater size and weight of metal. A mile of No. 9 wire weighs 320 pounds, but a mile of two-inch pipe weighs 19,360 pounds, or over six hundred times as much; while six-inch pipe, with which the tanks are usually connected, weighs over five times as much as two-inch. It is not, therefore, astonishing that the pipe being struck at an inconsiderable distance from the tank, the loss of tension to the ground on which it lies should be insufficient to prevent a spark at the extremity of the pipe in the tank.

The great majority of tanks lost by lightning have been station tanks with pipes running over the roof; but there have been tanks burned where the only pipe connection was through the shell near the bottom, the spark evidently going from the end of the swing pipe.

Well tanks (of wood, and usually 16 feet in diameter and 8 feet high) are quite frequently destroyed, though not, I think, more frequently in proportion to their number than iron tanks. There is always a 2-inch pipe leading over the top of these tanks and resting against the derrick over the wall. This derrick, being 70 or 80 feet high, is very liable to be struck. The noteworthy point about these fires is that the pipe which leads to the tank has its other end tightly connected with the tubing and casing in the well, and is thus afforded the most perfect earth connection conceivable. Why is not the tension wholly relieved down the well?

When a tank is fired the roof is always blown off if there is several feet of gas space between it and the oil. There have been instances where this explosion was sufficiently intense to blow the tank to pieces. When, as has been the case this year, the tank is practically full the explosion only starts the roof, and the fire may be, and occasionally is, extinguished by covering the rents with wet blankets, or by turning in steam. Usually, however, a tank once fairly aflame has to burn, and attention is directed exclusively to saving adjoining property. In a country as broken as this, it is difficult to find sufficient ground to separate the tanks widely without going to unwarranted expense, so that from 200 to 300 feet is considered a fair interval between them—very many are much closer than this.‡

A tank once fairly on fire will burn from six to eight inches an hour, and will not endanger neighboring tanks (unless high wind carries the flames over them) for several hours. The danger comes usually from the "overflow"—the most extraordinary phenomenon attending an oil fire. After a period varying in a full tank from five to twelve hours, or even a little more, and when the oil has burned down about 5 feet, the tank suddenly and without any previous notice throws out in a grand flow from 8 to 12 feet (8,000 to 12,000 barrels) of burning oil. To prepare for this flood all energies are directed until it comes. Ditches are dug and embankments thrown up between the burning tank and other property, and, if possible, the ditches are made to open into fields where the oil can burn rapidly and without further damage. The oil burns on the ground or on water with incredible rapidity, and will not run very far from the tank; when the flow ceases, it loses its limpidity, as its lighter parts are consumed; and when carried forward by water the flames die out in a comparatively short distance, leaving the surface covered with thick dark green unconsumed oil.

At uncertain intervals after the first flow there will be smaller flows, and in from twenty-four to thirty-six hours the tank will be quite burned out.

The cause of these overflows is uncertain. They are probably owing, in part at least, to the heating of the subjacent oil, but not wholly.

At the Custer fire the superintendent went completely around within five minutes of the flow, and as far as he could reach the tank was quite cool to the hand. It was at first thought that by pumping water into the tank as rapidly as the oil burned away, and so keeping the oil burning in the top ring of sheets, the overflow would be prevented, as no tank had ever made a flow until after the oil had burned below the first ring; but in the three cases tried, it had no success.

The theories offered to account for the overflow are chiefly:

1st. Heating the sides of the tank, causing the oil to boil;

2d. Currents of air caused by the fire itself; and

3d. That as the more volatile parts of the oil burn first, the burning surface will, after a time, become thick enough to seriously impede the free flow of gas from the oil beneath; and this obstruction becomes sufficient to permit or cause the accumulation of a quantity of gas so considerable as, when it is suddenly relieved, to cause the overflow.

It is certain that the force exerted is very great. At Custer the flow was made with such vehemence as to extinguish the flames in the tank, and for several minutes the oil left in the tank was not burning—only catching again from the fire outside.

To shorten the time during which the tank burns, it is usual to "shoot" it with small cannon or with rifles.* Through the hole thus made a considerable quantity of oil escapes, and though the area and intensity of the fire is increased, the time of danger is lessened. (When spurting from holes made by rifle balls, the oil burns with an exceedingly brilliant, pure white flame, almost comparable to the electric light.) Another object in shooting is to lessen the overflow by reducing the volume of unburned oil in the tank. The flames of a burning tank take a whirling motion tending toward the center of the tank; when there is no wind the column of flame and smoke covers about two-thirds of the surface of the tank, the strong rotary movement drawing the flames from the circumference. The combustion is naturally very imperfect, and the column is chiefly dense black smoke through which the flames in great brilliant jets of fire burst continually.

As it seems to be a practical impossibility to save the tank when once fairly aflame, the great desideratum is a means of excluding the air from the surface of the oil. The practical difficulty is the small specific gravity of oil (0·785 to 0·800). A liquid lighter than oil and non-combustible, non-volatile, and not mingling with oil, would solve the whole question of petroleum fires. Floating roofs cannot be used, because of the posts needed to support the actual roofs, and also because of the changes in the shape of the shell already alluded to, and which are often very great. Various ways of introducing carbonic acid gas have been proposed, but the surface is so vast, while the merest spark left anywhere is quite enough to start the flames again, that no confidence is felt in its being successfully employed. It has been thought that the air space in stock tanks might be filled with this gas, and as there is practically no draught it would probably remain until displaced by the gas rising slowly but continuously from the oil, or absorbed by the oil itself.†

REMARKS ON THE ABOVE BY PRESIDENT HENRY MORTON.

The foregoing very clear description of the arrangement of oil tanks, and of their mode of connection with the lines of pipe by which they are filled and emptied, presents the problem of the cause and prevention of fires in these tanks in a very definite form.

Looking at the matter as a problem in electric science, we see, in the first place, an immense network of iron pipe, forming an excellent system of electrical conductors, stretched out over a vast area of country, and thus subjected, under conditions of the disturbance of atmospheric electricity as in thunderstorms, to inductive actions tending to send powerful currents through them in various and varying directions.

The comparison of this system of pipes with the telegraphic wires is correct, as is also the conclusion that the greater size and consequent better conducting power of the pipes may well make up for their inferior insulation. In illustration of this I may mention, in the first place, an accident at the Hoosac Tunnel, where a lightning flash followed the track for several hundred feet into the tunnel, and did much damage there, though the track, sleepers, and bed were dripping with moisture.

Again, I have known an electric danger signal to be successfully operated where the tracks were part of the circuit, and the insulation of one track from the other was found practically sufficient, even when both were entirely submerged in water for some two hundred feet.

Of course there was great loss by leakage of the current, but enough followed the conductors to operate the apparatus, notwithstanding the short road offered from track to track by the soaked earth and overflowing water.

Another very instructive instance was found in this vicinity:

There is here an incline plane for raising horse cars from the river level to the top of the bluff or Palisades to the west of the river. The hoisting machinery for this is controlled by a man at the top of the incline, who, with his hands, works valves which regulate the hoisting engine, and, with his feet, steam brakes which act on the drums on which are wound

* A lightning rod, if properly attached, is believed to be of service. During last summer nearly all the tanks under the control of the United Pipe Line were rodded in the following manner:

Two bands of iron, 4 in. by ⅛ in., were run across the roof at right angles to each other, and were riveted to the angle iron at the edge of the shell.

Where these iron bands crossed, a piece of iron ¼ in. thick is inserted, and the bands are riveted to it and to each other. An inch hole is also tapped at this place and an inch round rod 21 feet high is screwed into it. This rod is supported by eight guys of No. 9 wire, which run from the rod to the bands.

The bands are further fastened to the roofing iron by lag screws.

All the joints are carefully cleaned when put together, and the electric connection of these parts is tested from time to time.

Recent tests show that in no case is the total resistance of connections, etc., from the end of the rod to the shell of the tank, over one one-hundredth of an ohm.

* Now done in every case.

† All tanks built since last summer have been provided with an arrangement of valve which renders the use of this swing pipe no longer necessary.

‡ All erected last year were set 300 feet apart, and those now building 350 feet from shell to shell.

* It has recently been demonstrated that the overflow of a burning tank can be prevented with certainty by shooting it with a three-and-a-half inch gun. About a dozen shots are required to empty the tank. The oil burns rapidly outside the tank, and does not run more than a hundred feet on the level. The only danger is that the tank may burst from the blows of the shot. A plan is now under experiment by which a hole may be cut with a machine operated from a safe distance.

† Much study has been given to extinguishing fires, and it is thought that with a large boiler capacity it would be impossible to smother them when the roof is not too far gone, and a number of 30 horse (about) portable boilers mounted, are included in the fire department. Also a large gas engine built by the Babcock Extinguishing Co., with a capacity of 900 cubic feet of gas per charge, which can be and has been charged and discharged in 30 minutes, but the results have been unsatisfactory, *e. g.*, two charges were put into one of the smallest tanks, where there was but about 9,000 cubic feet of space unfilled with oil), and yet samples of the gas taken from all parts of the tank burned freely; the CO_2 seemed to have absolutely no deadening effect whatever. Twenty-five samples were taken the first day, ten the next, and three the third day. The tank had a bottom only 66 feet in diameter, and great care was used to keep the inflowing carbonic acid from stirring up the oil. A "charge" for the engine is 500 lb bicarb. soda, 250 lb. sulph. acid, 500 lb. water so that 1,000 lb. of soda and 500 lb. acid were unequal to the task of killing the combustibility of 9,000 cubic feet of mixed air and oil gas.

the wire ropes which lead down the incline. Some years ago, when this apparatus was first put in use, the man operating it received several times severe electric shocks during thunderstorms. The matter was referred to me, and on examining the situation I noticed that the valves operated by hand were in close connection with the boiler, which with its furnace and tall iron chimney was at the top of the hill, while the brakes operated by the feet were in close connection with the ropes and tracks leading to the foot of the incline. Several pipes, etc., made more or less perfect connections between these two systems, but yet I judged that when a powerful discharge, which might easily go on without even a lightning flash, was passing from the clouds over the smoke stack through the boilers, etc., to the wire ropes, and so on to the foot of the hill, a part might pass through the man.

I therefore had the two sets of valves and levels, as close as possible to where the operator touched them, connected to each other by heavy copper straps (so bent as to allow free motion of the parts), and since then, I am informed, there has been no difficulty whatever even during the most violent electric storms. This experience bears directly on the oil tank problem, as I will explain at length further on.

To return, however, to the general problem now before us. It is manifest that such a system of conductors as is constituted by the united pipe lines is certain to have at various times charges of electricity more or less intense developed in it, and these will flow from one part to another, and tend to discharge into other conductors in their vicinity which may for any reason be in a different electrical state.

Passing next to the tanks, we find in these immense metallic shells capable of receiving heavy electric charges from electrically charged clouds or the like, and in all probability pretty well insulated from the ground. Dry earth is a very good insulator, and if it is more or less soaked with petroleum it would be still more so. Such a body of metal as an oil tank would acquire an immense inductive charge from a neighboring thunder cloud, and when the latter was discharged by a flash of lightning to a distant cloud or other object, the suddenly liberated electricity would have enough tension and volume to send a spark across from the tank side to the bent pipe (which, being in connection with distant parts, would be almost certainly in a different electric state) even if most of the charge passed harmlessly through the straps, etc., by which the pipe is attached to the tank.

When an electric charge has several paths it does not select the shortest or easiest alone, but divides itself among all in proportion to their conducting power. Thus, if there were two paths, one ninety-nine times easier than the other, 99 per cent. of the charge would go by the easier path, but 1 per cent. would still go by the other.

As an example of such an action as I have described, I would cite the case of the government powder magazine at Bombay. This was an iron building, with lightning rods insulated from it. During a thunderstorm it was exploded at the instant that a lightning flash struck from a cloud overhead to a point half a mile off. The induced charge, suddenly relieved somewhere in the building, jumped across some gap, though the whole mass was essentially in metallic connection.

Even if the tanks should have a perfect ground connection, there might still be a spark from the pipe to the tank, due to the different electric condition of the location of the tank and some other large area traversed by the pipe. In other words, a discharging of the pipe line through the tank into the earth, or *vice versa.*

The only way, as it seems to me, by which this difficulty can be met, is fortunately a simple one, and very much like that which I applied at the inclined plane mentioned above, namely, to put a good metallic conductor between all points where sparks might possibly occur.

Thus, in the case of the overhanging pipes, I would rivet, and if possible also solder, a short rod of iron from the lower edge of the pipe to the nearest point of the shell of the tank.

The swing pipe presents greater difficulty. It would not answer to trust to a chain. Even with a clean iron chain the discharge of a heavy battery shows light at every link, and with the insulating oil on it, it would be much worse. Wire rope would be much better, and moreover, everything must be done to secure perfect contact between all other portions of the circuit, from pipe end to tank, as any resistance introduced anywhere would defeat the whole plan. The general principle, however, of putting in a good metallic conductor wherever a spark might occur, is, I am convinced, the safe one to follow.

As regards the overflowing of a burning tank, I have no doubt that this phenomenon is to be explained very much in the manner already suggested.

I have had much experience in boiling down mixtures essentially like those constituting ordinary petroleum.

On no less than three occasions, such solutions, when being gently heated so as to distill off the more volatile portions, have suddenly entered into ebullition with such violence as to project the entire contents of the flask against the ceiling of the room.

This was essentially a case of superheating of a liquid, followed by violent ebullition or "bumping" as it is generally called.

In the case of the gas tanks there is no doubt a thick, dense layer of less volatile petroleum formed on the surface of the liquid in the tank. Beneath this the more volatile portion of petroleum not yet acted upon is gradually heated by conduction down the sides, and, thanks to the absence of points to assist the formation of bubbles of vapor, and to the restraining of the overlying thicker layer, this may rise far beyond the boiling point of the more volatile constituents without any escape of vapor. At last the equilibrium is overcome at some point, and the superincumbent layer yields by the relief of pressure; a violent ebullition takes place immediately around that point; the more volatile lower liquid surges up and mixes with the denser and heated surface layer, which again increases the action; this, and the surging from side to side, caused by the local relief of pressure, brings the oil in contact with the hot sides of the tank, and so the violent boiling over is brought about.

In a small vessel violent agitation and constant mixing of the mass is the best preventive against this sort of action; but to do anything of the sort with a burning oil tank I hardly know how to suggest. An active jet of steam kept running up through the oil might do good.

Carbonic acid, at the beginning of a fire, I should suppose, would be of efficient service, and all are familiar with the methods which have been used, with more or less success in applying it.

Beyond this I know of nothing which could be expected to do any good to a tank on fire.

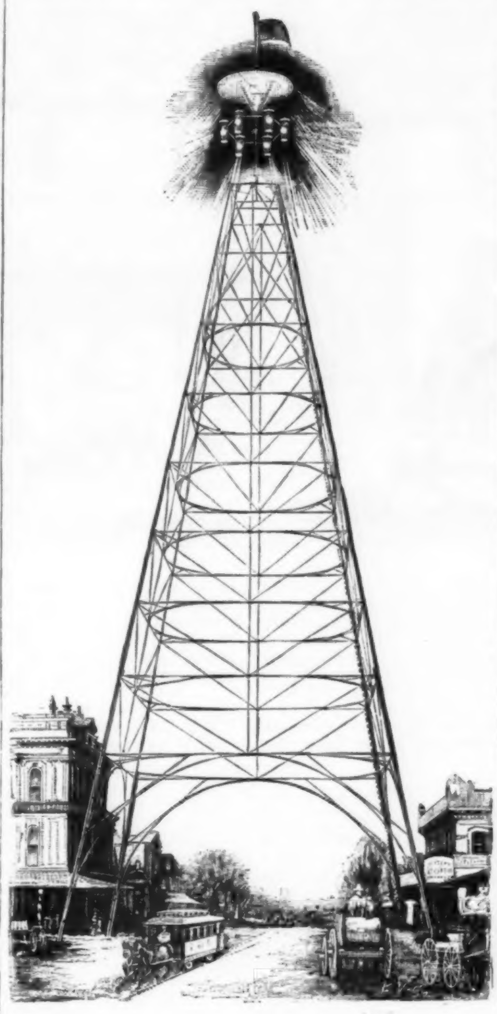
Prevention seems to be the likeliest, as it is the best cure for the evil, and in this relation I regard the use of conductors, as above described, as very promising.

THE SAN JOSE ELECTRIC LIGHT TOWER.

The accompanying cut represents the electric light tower, 200 ft. high, erected at the intersection of Santa Clara and Market streets, San Jose, Cal. It commences at the four corners of the streets with four inch gas pipe, which size is used for a distance of 100 ft., then 50 ft. of three-inch, followed by 50 feet of two-inch, the diagonal and circular braces being of smaller sized pipe. It has a width of 75 ft. at the base and 4 ft. at the top, and is crowned by a shield which acts not only as a protection for the lamps, but also serves as a diffuser of light.

There are six lamps of 4,000-candle power each, furnished by the California Electric Light Co., and driven by a No. 6 Brush dynamo-electric light machine with an expenditure of nine horse-power. The effect produced is very much like bright moonlight, the lights being so high that none of the direct rays reach the eye. For a distance of half a mile from the tower in all directions the light is brighter than would be produced by an ordinary gas lamp every 75 ft., while on the two streets over which the lights are placed there is sufficient light for ordinary purposes for a distance of two miles.

To Mr. J. J. Owen, editor and proprietor of the San Jose *Mercury*, belongs the credit of conceiving this the most beautiful, effective, and suitable erection for the illumination of a city by the electric light, and the success of the experiment has exceeded the most sanguine expectations of the projector. Some time since the City Council ordered all the gas lamps extinguished, in order that the merits of the tower light might be tested. The result was, that one-third of all the gas lamps in the whole city will remain ex-



THE ELECTRIC LIGHT TOWER AT SAN JOSE, CAL.

tinguished, the tower light being adopted in their stead, and it is now running permanently. It was never expected that one tower would light the whole city. At first five or six were thought necessary, but it is now decided that four will be all that will be needed, and that number will give a much greater light than could possibly be obtained from other methods of illumination, and the tower system will have the advantage of casting the light in the suburbs, where no gas lamps were erected, but where the property was taxed for their maintenance.

KEYLESS WATCHES.

By M. Grossmann, Watch Manufacturer, Glashuette, Saxony.

A watch is, more than many other articles, dependent upon the reigning taste, to the tyranny of which its construction must be subjected.

If there be any way in overcoming the inconveniences in the construction of keyless open-faced watches, it must be found in the employment of another system of transmitting the winding power. As long as flat, bevel, and contrate wheels are exclusively employed, the difficulty can only be eluded by a construction just as vicious as the before-mentioned ones. A combination of an endless screw, and one or two angular gears, seems to afford a greater liberty of disposition; but I have not seen as yet a commendable construction of this kind. It seems the idea has not yet been sufficiently studied.

The source of difficulty lies evidently in the following circumstances. If the winding operation is to be performed with a certain moderate number of revolutions of the winding knob, a very small wheel on the barrel arbor must be selected for receiving the action of the screw; but then the place for this latter must be granted above or under the barrel, and this necessarily increases the height of the movement. If, on the contrary, the wheel in the barrel arbor is large enough to admit the screw gear beyond the circumference of the barrel, the winding would be so excessively slow as to necessitate a transmission of power by a multiplicative train.

Some time ago I combined an open-faced keyless movement with greater ease in the arrangement of the train by having a rocking platform under the dial. The pendant and barrel are at an angle of 45°, taken from the center, and the sizes of the train wheels are quite normal. The third wheel is fastened to a collet on the lower end of the pinion arbor, and moves in the space between the barrel head and the lower bridge. This space is quite sufficient for having the barrel and the third wheel amply clear of each other, and on the other side of the barrel the center wheel is placed quite in the usual way. A movement on this plan is hardly any higher than a key-winder of the same breadth of main-spring.

It remains now to speak of some other designs for winding in which the force is not applied by the pendant. There were some old watches with a kind of keyless action, by turning the dome of the watch-case. This, however, has found no followers, in consequence of the impossibility of a dust-proof adjustment of the case, and because there were no means of setting the hands, except in the usual way—by using a key.

Other inventors had a circular rack, operated on by a slide projecting from the outside of the case, then winding by an intermittent or reciprocating motion.

Others, again, utilized the up and down motion of the front cover of a hunting-case for winding up a small part of the spring, on the supposition that a hunting watch will undoubtedly be opened a certain number of times during the day, and thus be kept a-going. It is not difficult to estimate the value of an arrangement based upon such suppositions for its efficiency. If a small number of repeated opening and shutting the case is sufficient to maintain the daily march, then the strain on the joint of the front cover of case must be excessively strong, and the consequence of it is the rapid wear of that joint. If, on the contrary, a considerable frequency of manipulations is required, this strain is less dangerous, but the device is liable to fail if the watch is not opened so many times.

An old and very original plan of keyless watches is still to be observed in a few specimens. In these watches the winding of the mainspring takes place through the motion imparted to them by the walking of the wearer, and which requires a good long walk every day for being kept a-going, or, instead of this, a good while of shaking up and down.

This idea has been taken up lately by A. von Löhr, Vienna, Austria. He has completely remodeled the old watch, and improved its weak points, so that it begins to enter earnestly into the competition with the modern keyless watches. The most important of his improvements consists in a better relation between the movement of the swinging body to the quantity of winding operated by it; so that a walk of one hour is sufficient to rewind the spring as much as it requires for keeping it a-going for twenty-four hours. Thus the daily movements of even the most sedentary person are more than sufficient for this purpose.

Besides, the better qualities of this watch (he calls it the "Perpetuale") are provided with an indicator, showing, by a hand on the dial, the actual tension of main-spring in each given moment.

When constructing a keyless mechanism, it is very desirable to establish a certain relation between the turns of the winding knob and those produced at the barrel arbor. In the greatest part of carefully made keyless watches, each revolution of the winding pinion operates one-third of a turn of the barrel arbor, or nearly so. This is a proportion which ought not to be much deviated from, in whatever direction; for if a greater speed is given to the winding, the operation is too hard to perform, especially for tender fingers. If, on the contrary, the winding effect is distributed over too great a number of turns, the action will be very easy, but, at the same time, a great power is put into the hands of the person winding, and this power may prove fatal to the acting parts, if not used with the appropriate discernment. Especially, the end of the winding operation, in such cases, is attended with dangers for the stop-work, the teeth of barrel, center pinion, etc.

With the rocking-bar mechanisms, the relations of turns is simply in the ratio of the numbers of the winding pinion and the barrel wheel. But the other group of keyless works having a multiplication of speed by the flat wheel moving on the axis of the contrate wheel, the ratio between the numbers of these two must be taken into calculation. If, for example, the winding pinion has 12 teeth, the contrate wheel 24, the flat wheel on it 40, the barrel wheel 60 teeth, the result will be

$$\frac{12\times 40}{24\times 60}=\frac{1}{3};$$

that is, one revolution of the pinion operates one-third revolution of the barrel arbor.

There is another danger resulting from violent winding in those watches which have a large winding wheel with fine teeth, and the click work acting in the teeth of this wheel. Any immoderate winding effort suddenly cut off by the action of the stop-work, and generally at the opposite end of the barrel arbor, produces a small degree of torsion of this latter, and one more tooth of the wheel is forced to pass the click. From this moment the watch acts under the influence of the full power of the main-spring, increased by the reaction of this torsion transmitted by the stop-work, and it begins to bank violently, and often continues so for some minutes. This is always accompanied with no small danger for the acting parts of the escapement, and, in case of no lasting injury to the watch, it produces a considerable deviation of rate.

Many a good keyless watch, when carefully treated, with an irreproachable rate, has been discredited by irregular performance, resulting from rough treatment in winding.

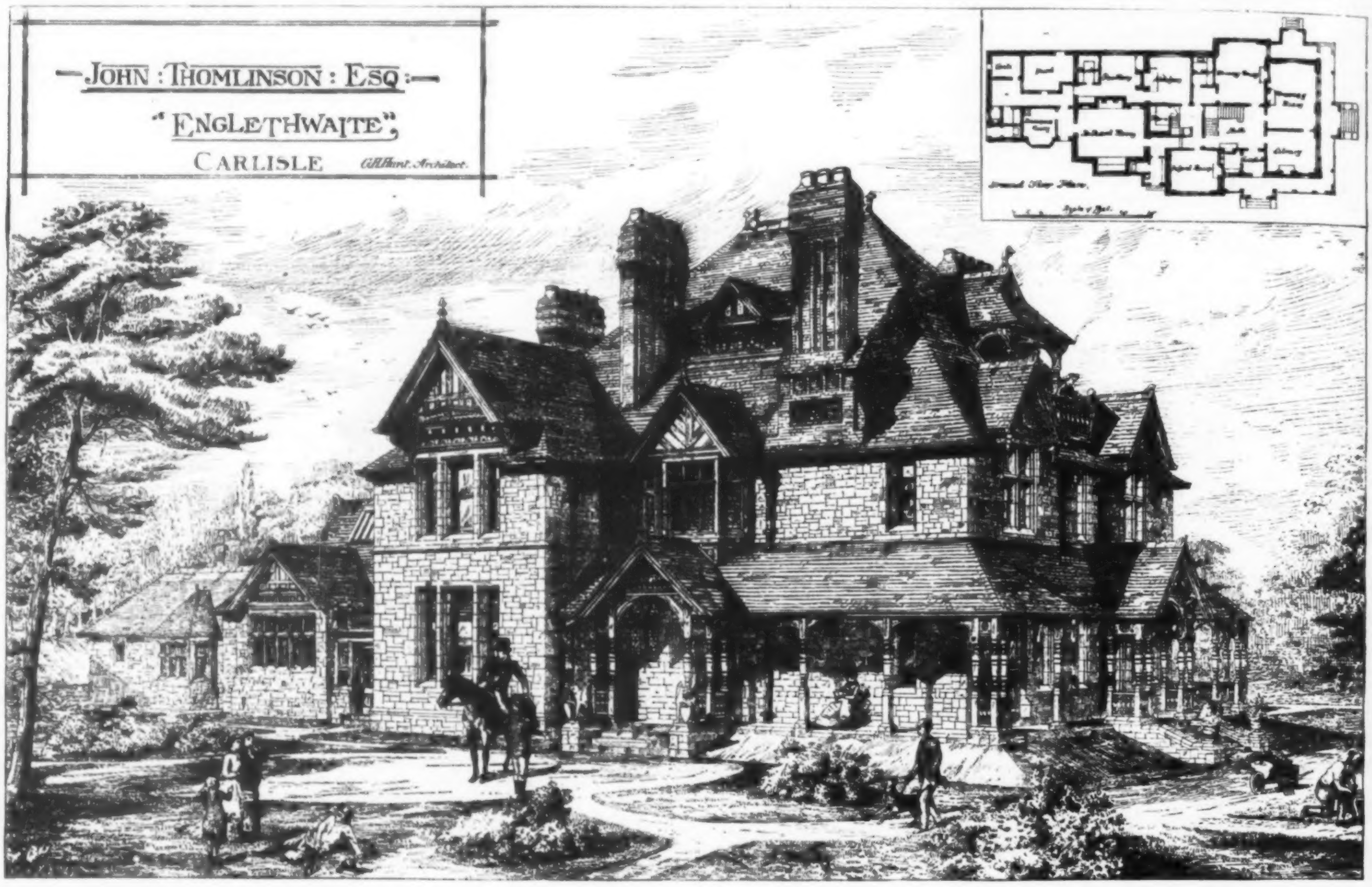
A very simple remedy against this inconvenience consists in giving the click a small amount of shake on its screw or stud. The recoil resulting from this shake is sufficient to ease any torsional strain of the kind above described.

I have also made keyless watches with an extra ratchet underneath the large winding wheel on the barrel arbor, and found them answer quite well. The ratchet was taken of the size of that in a key-winding watch, and, with rather vigorous teeth, it has sufficient recoil to make up for any torsion. The room for this ratchet is abundant, and the tail of the click, if made rather long, allows for letting down the spring without taking off the barrel wheel. A click-work of

this kind never causes any trouble in casing, while those click-works which are laid in the level of the winding wheels and at the edge of the larger ones of them, sometimes are troublesome to get clear from the dome of the case.—*Watchmaker.*

ENGLETHWAITE, NEAR CARLISLE.

THIS house has been recently erected for Mr. John Thomlinson from designs prepared by Mr. G. H. Hunt, architect, London. It is built with stone quarried on the estate,



and stands in a fine position, with beautiful views all round. Some of the gables are timber-framed, and a veranda runs round the greater part of three sides of the house. The internal fittings are of pitch-pine and walnut.—*Building News.*

MINING AND INDUSTRIAL EXPOSITION AT DENVER.

THE National Mining and Industrial Exposition will open its first exhibition at Denver, Colorado, August 1, 1882.

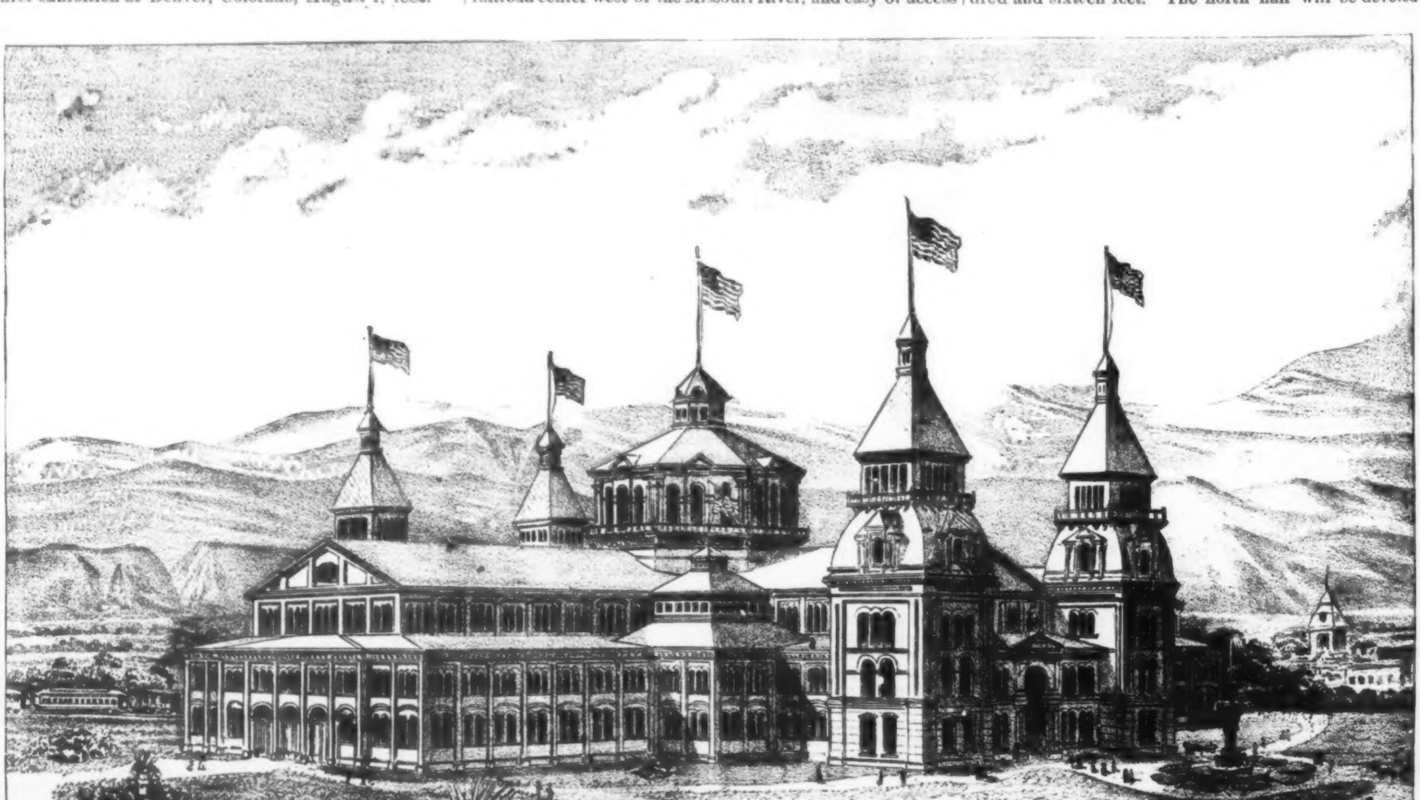
Its design is a very comprehensive one, and includes a general display of the mineral resources of the entire country, together with all manufactured articles that seek a market in the mining regions. Its purpose is to show our people where to procure that which is most needed to hasten the development of the peculiar country west of the one hundredth meridian; to give inventors and manufacturers the opportunity for a critical examination of the resources of the extreme Western States, and stimulate the invention and construction of what is needed to make these resources more rapidly available.

Prizes for excellence will be awarded and a lively competition encouraged. Mining and other machinery, the various processes employed in smelting, reducing, and concentrating ores will be fully represented. Ores, building stone, fire and potter's clay, coals, timber, cereals, and vegetable products will also be exhibited, and manufactured goods of all descriptions will be shown.

The geographical location of Denver as a proper point for such an exposition is unexcelled. It is the most important railroad center west of the Missouri River, and easy of access by first-class roads radiating toward all points of the compass. It contains, and is surrounded on all sides by, an intelligent and energetic population. The climate is too well known for its extraordinary salubrity and health-giving properties to call for extended notice here, and the large annual increase of its visitors for health, pleasure, and profit, is a sufficient guarantee to exhibitors that their wares could not be placed to better advantage

The building now being prepared for the reception of exhibits, of which we give a sketch from *Inter Ocean*, will be a permanent structure of stone, brick, glass, and iron, easy of access from all parts of the city, amply provided with refreshment and retiring rooms, brilliantly lighted both day and night, and furnished with ample motive power for driving such machinery as may be shown in practical operation. It will have an area of nearly one hundred and fifty thousand feet for the proper arrangement and display of goods.

It will be a cruciform; its front facing the west. Its greatest length is five hundred feet, and depth three hundred and sixteen feet. The north hall will be devoted ex-



PROPOSED BUILDING FOR THE DENVER MINING EXHIBITION OF 1882.

clusively to machinery in operation, and will be furnished with all needed appliances. The other portions of the building will be used to display the various exhibits in mineralogy, manufactures, and the arts.

SOLIDIFICATION BY PRESSURE.

IT was discovered by Faraday, in 1850, that pieces of ice readily freeze together under pressure even in water considerably above melting temperature, and this discovery led him to extend his experiments in the same direction, but a series of resultless trials forced him at last to acknowledge that, as far as his experience went, the phenomenon appeared to be peculiar to ice. The then new discovery excited the greatest interest; the results of Faraday's experiments were welcomed by Tyndall, who turned them to account in his glacial theory, but the unfavorable results of further trials may have discouraged others from following up the investigation.

The first theoretical explanation, with which, however, Professor Tyndall, in consequence of his own observations, could not pronounce himself satisfied, was given by James Thomson; other theories soon followed, advanced by Pfaundler, Ruehlemann, Carl Schultz, Jungk, and others, while the experimental side of the question appears to have been neglected for some time.

Compared with Faraday's experiments, quite an abundance of new material has of late been supplied by Mr. Walthère Spring, who has published the results of his researches in a recent number of the *Ann. Chim. et Phys.* By submitting a great number of bodies, both organic and inorganic, in powder and mostly at ordinary temperatures, to high pressures, he obtained results which, though probably not surprising, are certainly highly interesting.

A pressure of 2,000 atmospheres at ordinary temperature proved sufficient to change lead filings into a solid block of a specific gravity of 11·5, the figures generally quoted for lead being 11·4; under 5.000 atmospheres lead becomes fluid. Bismuth, tin, and zinc powder behaved similarly under pressures of from 5,000 to 6,000 atmospheres, and while aluminum and copper filings, and also antimony powder, were compressed into solid metallic blocks at similar pressures, no complete union of particles could be obtained with spongy platinum.

Mr. Spring's compressing apparatus being made of steel, permitted a maximum pressure of but 10,000 atmospheres, so that harder metals could not be tested; but it appears, as a result of these investigations, that the pressure required for solidifying metals when in the powdered condition depends mainly on their hardness, or in other words, that the welding capacity of metals at ordinary temperatures is simply a function of their hardness, so that they would unite more easily when hot and therefore softer.

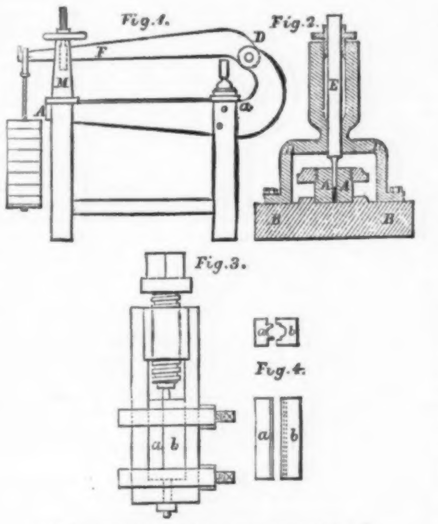
Turning now to non-metallic inorganic bodies, we find that those occurring in different allotropical modifications, such as phosphorus, sulphur, and others, will always assume, under sufficient pressure, that modification with the highest specific gravity. Amorphous carbon underwent no change, while crystalline carbon, or graphite, would be compressed into a solid block.

With other inorganic substances Mr. Spring obtained somewhat similar results, and having extended his experiments over thirty-four different bodies, he came to the general conclusion that substances in a crystallized form would readily unite under pressure, while amorphous bodies resisted all pressure, and only those which are also known to exist in a crystallized modification gave satisfactory results, and it may be assumed that previous to becoming solidified they changed into their crystalline form. The softer the materials the more ready seem their particles to unite, and some of his products of compression Mr. Spring describes as closely resembling definitely characterized minerals. He, for example, obtained pyrolusite from manganese dioxide powder, and zincblende from sulphide of zinc. Powders of crystalline substances, such as common salt, were compressed into more or less transparent blocks, becoming in some cases fluid at increased pressures, while in a hard block, resulting from anhydrous sodium carbonate, the separate grains were still distinctly discernible. A pressure of 6,000 atmospheres showed no effect on carbonate of lead, while even glass particles commenced to unite at this pressure. Of organic substances eighteen were brought under the piston of Mr. Spring's compressing apparatus, and some curious results were obtained with these. Wax kept at a temperature of 13° Cent. became completely united at 260 atmospheres and at a pressure of 500 atmospheres began to melt, while paraffin would still exist as a solid body with more than ordinary transparency, under nearly 2,000 atmospheres. Camphor and oxalic acid will weld easily, gum arabic, sealing wax, and potash prussiate also. Starch appeared petrified after compression; 6,000 atmospheres produced a very hard block, transparent at the edges, with a porcelain like fracture; with sugar only an imperfect union would be obtained, and resin offered great resistance. A solid piece of coal was reproduced from coal powder, and peat changed into a brilliant black block, without any organic texture, becoming plastic under a pressure of more than 6,000 atmospheres. This specimen was examined by several persons, and pronounced to be exactly like ordinary coal; on being subjected to distillation it produced a solid block of coke. Further experiments in this direction led Mr. Spring to conclude that heat accompanied with a pressure of from 200 to 3,000 atmospheres may have sufficed for the production of our natural coal stores.

Submitted to the highest pressure the apparatus would admit no change whatever could be observed in dry cotton or wool, while the same materials, when moist, could be compressed into a solid mass in which organic texture was no longer perceptible. Bone black resisted all pressure.

Mr. Spring further ascertained the influence of pressure under circumstances which rendered chemical reaction possible. Cailletet and Pfaff are in this direction his predecessors. Mixtures of powders of different substances, for instance, copper filings and sulphur, were subjected to pressure with satisfactory results, such as might have been expected; this, however, of course, only applies to such compounds in which the volume of the products is less than the sum of the volumes of the initial parts. All substances tested by Mr. Spring were used in form of fine powders, in order to secure a contact of the greatest possible surface, and the conclusions he draws from his results, although somewhat bold, seem to some extent to be borne out by experience. He compares substances in a fine powder to gases, and proves that pressure reunites what has been separated by mechanical or other forces, and as a support to his conclusions quotes the well known fact that mixtures of air with fine particles of dust of solid bodies may be as explosive as mixtures of air and gases.

The apparatus generally used by Mr. Spring for compressing is shown in Figs. 1 and 2, the former representing a general elevation, while the latter figure represents a section through the compression chamber. It consists, as will be seen, of a steel cylinder, A, about 1½ in. in diameter, and 2 in. high, with a hole of about ⅜ in. in diameter, bored through. The cylinder consists, for convenience of removing the compressed blocks, of two halves; the surfaces being perfectly turned up and fitting at the bottom into a recess formed in a cast-steel block, B, are held together at the top by a slightly tapered nut. Over the compression cylinder, and bolted to the steel base, B, is a bronze chamber, D, in connection with an air-pump, and extended at the top to form a guide for the enlarged piston, E, the latter passing through



SOLIDIFICATION BY PRESSURE.

a stuffing block. The pressure was produced by means of weights, acting on the lever, F, pivoted in a forked piece at D, which latter forms the base upon which the little compressing chamber rests. The whole is erected on a wooden stand. A spring dynamometer, at M, indicates the pressures; the weight of the lever alone produces a pressure on a small piston of about 260 atmospheres, while the apparatus would admit of a pressure of 10,000 atmospheres, within the limits of elasticity of the levers.

Another apparatus was constructed by the experimenter for working at higher temperatures; this was a similar steel cylinder made in halves, the edges being, however, made to overlap each other, so as to obtain a more perfect joint, and the lever was moreover replaced by a strong screw spindle. The whole apparatus, shown in Fig. 3, is very compact, and can be readily heated, Mr. Spring depending for a thermometer on small pieces of metals of known melting temperature, which he attached to his cylinder. The results of these experiments, which we have briefly abstracted in this article, are of very considerable interest, and may lead to the better understanding of numerous processes which have been at work to form the natural deposits in and upon the surface of the earth; the subject once more brought into the foreground, no doubt experimenters will set to work, and after verifying Mr. Spring's results by their own experience, will extend their investigations.—*Engineering.*

PRACTICAL HINTS ON THE MANUFACTURE OF GELATINE EMULSIONS AND PLATES FOR PHOTOGRAPHIC PURPOSES.

By W. K. BURTON.*

THIS paper will, I imagine, be read before a mixed audience, some of whom have a complete knowledge of photographic processes, while others may not even know the meaning of the word "emulsion." I shall, therefore, try to explain accurately what we mean by the term, and shall then glance rapidly at the history of emulsions generally, so far addressing myself specially to those who have no knowledge of photography. I shall then enter more particularly into the question of the manufacture of a gelatine emulsion, demonstrating the process; and in this part of my paper I shall address more particularly those whom I suppose to have at least some photographic knowledge.

In all our modern negative processes, the object which we have in view in preparing a plate is to spread evenly on a surface, usually of glass one of the silver haloids. Those which are used are the bromide, the chloride, or the iodide. Any one of these can be made by combining nitrate of silver with the corresponding soluble haloid. For example, bromide of silver is formed by combining nitrate of silver with any soluble bromide. As an example, I have here a solution of nitrate of silver in water. I have also a solution of bromide of ammonia in water. I pour the one into the other, and a dense white precipitate is thrown down. This is bromide of silver. Now, in the manufacture of every photographic plate, this process takes place. It may either take place on the surface of the plate, in which case we have what is known as a bath plate; or it may take place before the film is spread over the plate, in which case we have an emulsion plate. To explain this matter rather more fully.

I have here a certain slightly colored transparent fluid. This is what is called "iodized collodion." It is a soluble iodide dissolved in collodion. Collodion is a substance which will form a thin film over a glass plate. If, therefore, I pour this iodized collodion over this plate, I shall have a film in which there is the substance necessary to form iodide of silver, with nitrate of silver, and you will see, that when I drop this plate into a bath containing nitrate of silver solution, it will lose its transparency and become white and opalescent. In fact, iodide of silver is formed on the surface of the plate, and a "bath plate" has been prepared.

Now, this is a very beautiful process, and one which is most pleasing in many ways, but it has its drawbacks. You have seen that, for one thing, some delicate manipulation is required. Not only that, but we are working with two most fickle substances. In practicing the wet process, the bath is continually going out of order. If the bath is right, then the collodion is wrong. Then the film itself is of such delicacy that a touch will destroy it; but the great difficulty is, that the plate must be prepared within, say, half an hour of the time it is to be used, and when once exposed must be developed within a few minutes, so that the photographer must have the whole paraphernalia necessary to manufacture the plates wherever he means to work them.

Very long ago, it suggested itself to photographers that the two substances, the iodide and the nitrate of silver, might be combined in the collodion before it was poured over the plate, so that the whole process of manufacturing the plate should consist in pouring the collodion over it. I need not enumerate the unsuccessful attempts that were made; suffice it to say that in 1864, Messrs. Sayce & Bolton succeeded in suspending bromide of silver, in a fine state of division, in collodion, which had afterwards only to be poured over a glass plate. This process I now demonstrate. I pour an alcoholic solution of nitrate of silver into a bromized collodion. You perceive the bromide of silver formed in a fine state of division. All that is necessary is to pour this over the plate to wash the latter, and an emulsion plate has been prepared and is ready for the camera. You see that the process is far simpler than the bath process, but the very great advantage of it is that, whereas the bath plate had to be used immediately after preparation, the "collodio-bromide" plate may be kept for a lengthened period, either before or after exposure.

The collodio-bromide plate was about the same in sensitiveness as the wet plate, and for long was the dry plate of the day.

It began, after a time, to suggest itself to the minds of various photographers that, possibly, some other vehicle than collodion might be used to hold the bromide of silver in suspension. In 1871, Dr. Maddox suggested gelatine as a medium, and experimented on it, getting good results. He prepared bromide of silver in a solution of gelatine of such a strength that it was liquid when hot, but in the form of a jelly when cold. He spread it over plates when warm, and allowed it first to set as a jelly, and then to dry.

In 1873, Mr. R. Kennett took out a patent for a "pellicle," which was simply emulsion prepared as by Dr. Maddox, but afterward dried. It had to be redissolved in warm water, when plates could be coated with it.

It was not, however, till 1878—when Mr. C. Bennet published the fact that if a gelatine emulsion be kept warm for a number of days, the sensitiveness increases enormously—that gelatine plates came to the front. Mr. Bennet's experiments demonstrated the fact, that in gelatine plates there might be a sensitiveness never before dreamt of by photographers—five times, ten times, or twenty times what they had been used to. It was afterward shown that if the emulsion be boiled instead of only being kept warm, a very much shorter period of time sufficed to gain the sensitiveness. It was again shown that if the emulsion be kept warm in the presence of ammonia, the process goes on with great rapidity. In 1879, was published a process in which boiling is recommended, but in which it is advised that a very small quantity of the gelatine necessary be introduced before boiling, the rest afterwards. This process is due to Mr. W. B. Bolton. It must be understood that a very considerable quantity of gelatine is required to make a solution which can be spread over glass, and which will "set" as a jelly on the plate; but that a much smaller quantity of gelatine is enough to keep the bromide of silver in suspension while it is being boiled. The advantage to be gained is that only a small proportion of the gelatine goes through the ordeal of boiling, which is one liable to decompose it.

I have not, up till now, touched at all on the subject of washing an emulsion. I have pointed out that, by combining bromide of ammonium with nitrate of silver, bromide of silver is formed; but we must recollect, also, that nitrate of ammonium is formed, and that this, if left in the emulsion, would be most hurtful. I here give the equation:

$$AgNO_3 + NH_4Br = Ag\,Br + NH_4\,NO_3.$$

Besides the nitrate, there is another consideration. It is quite impossible, in practice, to weigh out such accurate quantities of each of the two salts that they shall exactly convert each other. We must have a little of one or the other over, or, as it is said, we must have a slight "excess." This might be either nitrate of silver or bromide of potassium, but as an excess of nitrate of silver is found hurtful, the proportions of the two haloids are always so adjusted that there shall be an appreciable excess of soluble bromide, or if the emulsion be one to contain a chloride, of soluble chloride. Now, it is necessary, after emulsification and boiling, to get rid of both this excess of soluble haloid and of the nitrate. This is done by washing, and to the washing process, gelatine lends itself admirably. A gelatine solution, in the form of a jelly, is quite insoluble in cold water. All, therefore, that is necessary, is to break up the emulsion when in this form, and to allow it to soak in running water. The nitrate, which is soluble, and the soluble bromide, will each diffuse away.

Now, to pass on to the actual manufacture of an emulsion. The process which has worked best in my hands is the acid boiling process, and this I intend to demonstrate to-night. By working exactly as I am now about to do, I obtain plates of the very highest sensitiveness, and at the same time, of good quality.

I need scarcely say, that the operations which I now perform in bright gas light must, when an emulsion for practical use is wanted, be carried out in the deepest ruby light, and very little of that.

To begin, then, here is the formula:

I.

Nitrate of silver	400 grs.
Water	8 oz.

II.

Bromide of ammonium	220 grs.
Iodide of ammonium	15 "
Chloride of ammonium	15 "
Gelatine (Nelson's No. 1)	80 "
Water	8 oz.
Hydrobromic acid enough to make the solution just acid.	

III.

Autotype gelatine	450 grs.

soaked in water, and afterwards squeezed to get rid of as much of the water as possible.

A few remarks on the formula.

Iodide is recommended by Captain Abney, and I find that it adds greatly to the quality of the plates. Although chloride of ammonium is used in the preparation of this emulsion, it is not intended that there shall be any chloride of silver in the emulsion. The bromide and iodide are just estimated to convert the silver, using Wernerke's practical equivalents. The reason for using the chloride at all is that,

* A recent lecture before the Society of Arts, London.

I believe a greater degree of sensitiveness is gained by boiling in presence of an excess of chloride than with an excess of bromide. I have not myself been able to find that any advantage arises from the presence of the chloride of silver in the emulsion.

The amount of gelatine used in emulsification is rather greater than is sometimes recommended. I believe the quality of the plate is thereby improved. It may be asked why I do not give a definite quantity of acid; it is because the chemicals themselves are frequently acid. I believe that the success in getting a very sensitive, and at the same time clear emulsion, greatly depends on the amount of acidity of the solution. It should be just acid enough to show by litmus paper. If this is the case when the salts are first dissolved, nothing more is wanted. If not, add very dilute hydrobromic acid, till the solution will just turn blue litmus paper red. If it has been neutral at first, about one drop of strong hydrobromic acid will suffice.

I have found the autotype gelatine the best for the bulk, as frilling, in my experience, never occurs with it. It is very hard setting, but at the same time does not repel the developer as some gelatines do. Somewhat more than the quantity given may be used, if it be desired.

To emulsify, I pour the solution, No. 2, into a glass bottle—when at home I use a hockbottle; I afterwards add, little by little, the nitrate of silver, both solutions having been raised to a temperature somewhere approaching the boiling point. The whole is then poured into a large beaker or jelly can; this is covered with a cover consisting of a wooden dish, and placed in a saucepan. The lid of the latter is put on and the whole is allowed to boil. I coat a plate with the emulsion newly made. It will be seen that, on looking at a light through the plate, the light appears ruby red. The emulsion is said to be "red by transmitted light." As the process goes on, however, the color changes, and at last becomes blue. It is difficult to say exactly when the whole of the bromide of silver has been converted into the blue variety, but it may be discovered by gently drying a plate coated with the emulsion. The blue bromide and the red bromide will separate into patches. When all is converted to the blue the boiling may cease. The time taken in boiling seems to vary considerably with different manipulators; with me it is generally somewhere between one and two hours, but I have frequently boiled for several hours without producing fog, and have, in fact, never reached the fog-line, so long as the emulsion was kept distinctly but slightly acid. The bulk of the gelatine is then added, and the whole poured out in a flat dish to set.

When it is set quite stiff, it is cut up and placed in the "squeezer." It is pushed through wire gauze into a hair sieve held under water. This cuts it into very small particles, and if water be allowed to run through the sieve for half an hour, the soluble salts will all be washed away.

After this, the sieve is allowed to stand a short time, for some of the water to drain off. The emulsion is then heated, is filtered through two folds of a pocket handkerchief, and is spread on the glass. For this I use a small teapot as a pourer. I used at first to measure the emulsion for each plate, but can now guess the quantity with great accuracy. My teapot holds four ounces, and this will just coat a dozen, or rather eleven, half plates. I pour the emulsion on the plate while the latter is on the leveling shelf. I then take a glass rod in the finger and thumb of each hand; dip this rod into the pool of emulsion on the plate—the emulsion runs by capillary attraction along the rod to the edges of the plate, but no further. I lift the glass rod about a sixteenth of an inch; the emulsion rises with it. I pass it rapidly first to one end of the plate and then to the other, guiding myself by keeping my thumb and finger on the leveling shelf, and the plate is absolutely evenly coated. It is never removed from the leveling shelf till it is set. The plates are slightly warmed to begin with. The plates, after they are set, are reared on ends in racks, the design for which I got from Mr. G. F. Williams; they are then placed in the drying box to dry.

Plates prepared as I have described are quite as rapid as the average of the so-called instantaneous plates sold commercially. Captain Abney first pointed out that an emulsion got more rapid by keeping it cold after it was washed. In my experience this only happens when the emulsion is alkaline, or at least not acid. If to the emulsion, made as described above, about eight drops of strong ammonia be added to the pint, it will be found that, after a week's keeping, the plates made from it will be from two to three times quicker than before, and such are quicker than any commercial plates that I have used. This adding of a few drops of ammonia, simply to neutralize any acidity which may be in the emulsion, must be by no means confused with the process where digestion is carried on in the presence of one to two per cent. of ammonia, before washing.

I must say a word on a point that is often discussed. "Is it worth while for an amateur to make his own plates?" I certainly think it is not, if he expects to economize by it. If, however, he is such an enthusiast as to make plates for the pleasure he will derive from working those made by himself, instead of those purchased, then by all means let him make them, but do not let him suppose that everything is to go quite smoothly, and that he is to have no trouble—at least, if he is aiming at rapid plates. It is easy to make a moderately rapid emulsion, and to make a number in succession with uniformity, but it is not so easy to make the plates. It is on the coating and drying of the plates that the difficulty comes. Then, if an exceedingly rapid emulsion is required, the difficulties increase, and, in fact, become very great; the amount of light admissible is so small, that manipulation must be performed more by feeling than by seeing.

We often hear people grumbling at the quality of commercial plates. My own surprise has been at the uniform excellence of the plates issued by all the leading manufacturers. If any amateur reaches the quality and uniformity of any of our first manufacturers, he may be well pleased with himself.

BEER ANALYSIS.

By J. N. HURTE.

THE following analyses of our beers may be interesting to English analysts. These beers are sold here in immense quantities, with loud declarations as to their purity and general excellence:

	Milwaukee.	Lieber's.	Maus's.	Schmidt's.
Specific gravity	1·0174	1·0229	1·018	1·0172
Extractive matter	7·312%	5·988%	6·33%	5·816
Sugar	1·895	3·126	4·060	3·440
Dextrin	3·880	2·644	2·060	2·283
Albumen	0·037	0·016	0·006	0·014
Bitter matter	1·530	0·202	0·118	0·074
Acidity as $HC_2H_3O_2$	0·159	0·281	0·309	0·080
Alcohol	5·35	9·99	5·284	4·640

Indianapolis, Indiana, U. S. A., Dec. 5, 1881.—*The Analyst.*

[Continued from SUPPLEMENT 329, page 5249.]

SOLIDS, LIQUIDS, AND GASES.

By W. MATTIEU WILLIAMS.

PART IV.

As already explained, all gases are now proved to be analogous to steam; they are matter expanded and rendered self-repulsive by heat. All *elementary* matter may exist in either the three forms—solid, liquid, or gas, according to the amount of heat and pressure to which it is subjected. I limit this wide generalization to *elementary* substances for the following reasons.

Many compounds are made up of elements so feebly held together that they become "dissociated" when heated to a temperature below their boiling point. Or their condition may be otherwise defined by stating that the bonds of chemical energy, which hold their elements together, are weaker than the cohesion which binds and holds them in the condition of solid or liquid, and are more easily broken by the expansive energy of heat. To illustrate this, let us take two common and well-known oils, olive oil and turpentine. The first belongs to the class of "fixed oils," the second to the "volatile oils." If we apply heat to liquid turpentine, it boils, passes into the state of gaseous turpentine, which is easily condensable by cooling it. If the liquid result of this condensation is examined, we find it to be turpentine as before. Not so with the olive oil. Just as this reaches its boiling point, the heat, which would otherwise convert it into olive oil vapor, begins to dissociate its constituents, and if the temperature be raised a little higher we obtain some gases, but these are the products of decomposition, not gaseous olive oil. This is called "destructive" distillation.

In olive oil, the boiling point and dissociation point are near to each other. In the case of glycerine, these points so nearly approximate that, although we cannot distill it unbroken under ordinary atmospheric pressure, we may do so if some of this pressure is removed. Under such diminished pressure, the boiling point is brought down below the dissociation point, and condensable glycerine gas comes over without decomposition.

Sugar affords a very interesting example of dissociation, commencing far below the boiling point, and going on gradually and visibly, with increasing rapidity as the temperature is raised. Put some white sugar into a spoon, and heat the spoon gradually over a smokeless gas-flame or spirit-lamp. At first the sugar melts, then becomes yellow (barley sugar); this color deepens to orange, then red, then chestnut brown, then dark brown, then nearly black (caramel), then quite black, and finally it becomes a mere cinder. Sugar is composed of carbon and water; the heat dissociates this compound, separates the water, which passes off as vapor, and leaves the carbon behind. The gradual deepening of the color indicates the gradual carbonization, which is completed when only the dry insoluble cinder remains. An appearance of boiling is seen, but this is the boiling of the dissociated water, not of the sugar.

The dissociation temperature of water is far above its boiling point. It is 5,072° Fah., under conditions corresponding to those which make its boiling point 212°. If we examine the variations of the boiling point of water, as the atmospheric pressure on its surface varies, some curious results follow. To do this the reader must endure some figures. They are extremely simple, and perfectly intelligible, but demand just a little attention. Below are three columns of figures. The first represents atmospheres of pressure—*i. e.*, taking our atmospheric pressure when it supports 30 inches of mercury in the barometer tube as a unit, that pressure is doubled, trebled, etc., up to twenty times in the first column. The second column states the temperature at which water boils when under the different pressures thus indicated. The third column, which is the subject for special study just now, shows how much we must raise the temperature of the water in order to make it boil as we go on adding atmospheres of pressure, or the increase of temperature due to each increase of one atmosphere of pressure. The figures are founded on the experiments of Regnault.

Pressure in Atmospheres.	Temperature F.	Rise of Temperature for each additional Atmosphere.
1	212·0	37·5
2	249·5	23·8
3	273·3	17·9
4	291·2	14·8
5	306·0	12·2
6	318·2	11·4
7	329·6	9·9
8	339·5	8·9
9	348·4	8·2
10	356·6	7·6
11	364·2	6·9
12	371·1	6·7
13	377·8	6·2
14	384·0	6·0
15	390·0	5·4
16	395·4	5·4
17	400·8	5·1
18	405·9	4·9
19	410·8	4·6
20	415·4	—

It may be seen from the above that, with the exception of one irregularity, there is a continual diminution of the additional temperature which is required to overcome an additional atmosphere of pressure, and if this goes on as the pressure and temperatures advance, we may ultimately reach a curious condition—a temperature at which additional pressure will demand no additional temperature to maintain the gaseous state; or, in other words, a temperature may be reached at which no amount of pressure can condense steam into water, or where the gaseous and liquid states merge or become indifferent.

But we must not push this mere numerical reasoning too far, seeing that it is quite possible to be continually approaching a given point, without ever reaching it, as when we go on continually halving the remaining distance. The figures in the above do not appear to follow according to such a law—nor, indeed, any other regularity. This probably rises from experimental error, as there are discrepancies in the results of different investigators. They all agree, however, in the broad fact of the gradation above stated. Dulong and Arago, who directed the experiments of the French Government Commission for investigating this subject, state the pressure at 20 atmospheres to be 418·4, at 21=422·9, at 23=427·3, at 23=431·4, and at 25 atmospheres, their highest *experimental* limit, 435·5, thus reducing the rise of temperature between the 23d and 24th atmosphere to 4·1.

If we could go on heating water in a transparent vessel until this difference became a vanishing quantity, we should probably recognize a visible physical change coincident with this cessation of condensability by pressure; but this is not possible, as glass would become red hot and softened, and thus incapable of bearing the great pressure demanded. Besides this, glass is soluble in water at these high temperatures.

If, however, we can find some liquid with a lower boiling point, we may go on piling atmosphere upon atmosphere of elastic expansive pressure, as the temperature is raised, without reaching an unmanageable degree of heat. Liquid carbonic acid, which, under a single atmosphere of pressure, boils at 112° below the zero of our thermometer, may thus be raised to a temperature having the same relation to its boiling point that a red heat has to that of water, and may be still confined within a glass vessel, provided the walls of the vessel are sufficiently thick to bear the strain of the elastic outstriving pressure. In spite of its brittleness, glass is capable of holding an enormous strain *steadily applied*, as may be proved by trying to break even a mere thread of glass by direct pull.

Dr. Andrews thus treated carbonic acid, and the experiment, as I have witnessed its repetition, is very curious. A liquid occupies the lower part of a very strong glass tube, which appears empty above. But this apparent void is occupied by invisible carbonic acid gas, evolved by the previous boiling of the liquid carbonic acid below. We start at a low temperature—say 40° Fahr. Then the temperature is raised; the liquid boils until it has given off sufficient gas or vapor to exert the full expansive pressure or tension due to that temperature. This pressure stops the boiling, and again the surface of the liquid is becalmed. This is continued until we approach nearly to 88° Fahr., when the surface of the liquor loses some of its sharp outline. Then 88° is reached, and the boundary between liquid and gas vanishes; liquid and gas have blended into one mysterious intermediate fluid; an indefinite fluctuating something is there filling the whole of the tube—an etherealized liquid or a visible gas. Hold a red hot poker between your eye and the light; you will see an upflowing wavy movement of what appears like liquid air. The appearance of the hybrid fluid in the tube resembles this, but is sensibly denser, and evidently stands between the liquid and gaseous states of matter, as pitch or treacle stands between solid and liquid.

The temperature at which this occurs has been named by Dr. Andrews the "*critical temperature;*" here the gaseous and liquid states are "*continuous,*" and it is probable that all other substances capable of existing in both states have their own particular critical temperatures.

Having thus stated the facts in popular outline, I shall conclude the subject of my next paper by indulging in some speculations of my own on the philosophy of these general facts or natural laws, and on some of their possible consequences.

PART V.

As already stated in Part 3 of this series, the conversion of water into steam under ordinary atmospheric pressure demands 966·6° of heat over and above that which does the work of raising the water to 212°, or, otherwise stated, as much heat is at work in a given weight of steam at 212°, as would raise the same quantity of water to 1,178·6° if it remained liquid.

James Watt concluded from his experiments that a given weight of steam, whatever may be its density, or, in other words, under whatever pressure it may exist, contains the same quantity of heat. According to this, if we reduced the pressure sufficiently to bring down the boiling point to 112°, instead of 212°, the latent heat of the steam thus formed would be 1,066·6° instead of 966·6°, or if, on the other hand, we placed it under sufficient pressure to raise the boiling point to 312°, the latent heat of the steam would be reduced to 866·6°, *i. e.*, only 866·6° more than would be required to convert the water into steam. If the boiling point were 412°, as it is between 19 and 20 atmospheres of pressure, only 766·6° more heat would be required, and so on, till we reach a pressure which raises the boiling point to 1,178·6°, when the water would become steam without further heating, *i. e.*, the critical point would be reached, and thus, if Watt is right, we can easily determine, theoretically, the critical temperature of water.*

Mr. Perkins, who made some remarkable experiments upon very high pressure steam many years ago, and exhibited a steam gun at the Adelaide Gallery, stated that red hot water does not boil; that if the generator be sufficiently strong to stand a pressure of 60,000 lb. load on the safety valve, the water may be made to exert a pressure of 56,000 lb. on the square inch at a cherry red heat without boiling. He made a number of rather dangerous experiments in thus raising water to a red heat, and his assertion that red hot water does not boil is curious when viewed in connection with Dr. Andrews' experiments.

I cannot tell how he arrived at this conclusion, having been unable to obtain the original record of his experiments, and only quote the above second-hand. It is worthy of remark that the temperature he names is about 1,170°, or that which, if Watt is right, must be the critical temperature of the water. Perkins' red hot water would not boil, as he states, being then in the intermediate condition.

So far, we have a nice little theory, which not only shows how the critical state of water must be reached, but also its precise temperature; but all this is based on the assumption that Watt made no mistake. Unfortunately for the simplicity of this theory, Regnault states that his experiments contradict those of Watt and prove that the latent heat of steam does not diminish just in the same degree as the boiling point is raised, but that instead of this the diminution of the latent heat progresses 30½ per cent. more slowly than the rise of temperature, so that, instead of the latent heat of steam between boiling points of 212° and 312°, falling from 966·6° to 866·6°, it would only fall to 895·1° or 69·5° for every 100°.

If this is correct, the temperature at which the latent heat of steam is reduced to zero is much higher than 1,178·6°, and is, in fact, a continually receding quantity never absolutely reached; but I am not prepared to accept these figures of Regnault as implicitly as is now done in text books (I was nearly saying "as is now the fashion"), seeing that they are not the actual figures obtained by his experiments, but those of his "empirical formulæ" based upon them. His actual experimental figures are very irregular; thus, between steam temperature of 171·6°, and 183·2° a difference of 11·6°, the experimental difference in the latent heat came out as 4·7°; between steam temperature of 183·2° and 194·8°, or 11·6°, again the latent heat difference is tabulated at 8·0°.

* Watt's own figure for the latent heat of steam at 212° was 950°, but I adopt that which is now generally accepted.

Regnault's experiments were not carried to very high temperatures and pressures, and indicate that as these advance the deviation from Watt's law diminishes, and may finally vanish at about 1,500° or 1,600°, where the latent heat would reach zero, and there, according to the above, the critical temperature would be reached. Any additional heat applied after this will have but one function to perform, viz., the ordinary work of increasing the bulk of the heated body without doing anything further in the way of conferring upon it any new self-repulsive properties.

Our notions of solids, liquids, and gases are derived from our experiences of the state of matter here upon this earth. Could we be removed to another planet, they would be curiously changed. On Mercury water might rank as one of the condensable gases; on Mars as a fusible solid; but what on Jupiter?

Recent observations justify us in regarding this as a miniature sun, with an external envelope of cloudy matter, apparently of partially condensed water, but red hot, or probably still hotter within. His vaporous atmosphere is evidently of enormous depth, and the force of gravitation being on his visible outer surface, 2½ times greater than that on our earth's surface, the atmospheric pressure, in descending below this visible surface must soon reach that at which the vapor of water would be brought to its critical condition. Therefore we may infer that the oceans of Jupiter are neither of frozen, liquid, nor gaseous water, but are oceans or atmospheres of critical water. If any fish-birds swim or fly therein they must be very critically organized.

As the whole mass of Jupiter is 300 times greater than that of the earth, and its compressing energy toward the center proportional to this, its materials, if similar to those of the earth and no hotter, would be considerably more dense, and the whole planet would have a higher specific gravity, but we know by the movement of its satellites that, instead of this, its specific gravity is less than a fourth of that of the earth. This justifies the conclusion that it is intensely hot, for even hydrogen, if cold, would become denser than Jupiter under such pressure.

As all elementary substances may exist as solids, liquids, or gases, or, critically, according to the conditions of temperature and pressure, I am justified in hypothetically concluding that Jupiter is neither a solid, a liquid, nor a gaseous planet, but a critical planet, or an orb composed internally of dissociated elements in the critical state, and surrounded by a dense atmosphere of their vapors, and those of some of their compounds, such as water. The same reasoning applies to Saturn and the other large and rarefied planets.

The critical temperature of the dissociated elements of the sun is probably reached at the base of the photosphere, or that region revealed to us by the sun-spots. When I wrote "The Fuel of the Sun," thirteen or fourteen years ago, I suggested, on the above grounds, the then heretical idea of the red heat of Jupiter, Saturn, Uranus, and Neptune, and showed that all such compounds as water must be dissociated at the base of the sun's atmosphere; but being then unacquainted with the existence of this critical state of matter, I supposed the dissociated elements to exist as gases with a small solid nucleus or kernel in the center.

Applying now the researches of Dr. Andrews to the conditions of solar existence, as I formerly applied the dissociation researches of Deville, I conclude that the sun has no nucleus, either solid, liquid, or gaseous, but is composed of dissociated matter in the critical state, surrounded, first, by a flaming envelope due to the recombination of the dissociated matter, and outside of this another envelope of vapors due to this combination.

SOME OF THE INDUSTRIAL USES OF THE CALCIUM COMPOUNDS.*

By THOMAS BOLAS, F.C.S.

Lecture IV.—Delivered December 11, 1881.

OTHER CALCIUM COMPOUNDS AND THEIR USES—THE PHOSPHORESCENT SULPHIDE—LIME SOAPS—BLEACHING POWDER—PHOSPHATES OF CALCIUM—THE HARDNESS OF WATER, ETC.

VERY many of the calcium salts possess the property of phosphorescence in a notable degree; that is to say, they absorb light when exposed to its action, and afterward slowly evolve it in the dark, the secondary or phosphorescent rays being generally of a lower degree of refrangibility than the absorbed rays. Some samples of fluorspar afford a good example of this phosphorescence. Here is some fluorspar which has been exposed to a powerful light, and although the gas is turned down, you cannot see the light which is evolved. If now the fluorspar is warmed by being placed on this piece of heated iron, the phosphorescence will be so far exalted that you will be able distinctly to see the greenish-yellow phosphorescent rays; the effect of heat being very greatly to increase the phosphorescent energy of any substance charged with light.

Chalk, limestone, shells, and plaster of Paris are generally more or less phosphorescent; but although the evolved light is energetic enough to produce a considerable effect on a sensitive photographic plate, it is not powerful enough to be very obvious to the eye, unless special precautions are taken for its observation.

One of the most phosphorescent bodies known at the present time is the sulphide of calcium, a body which may be readily obtained by heating a mixture of lime and sulphur to bright redness, or by heating sulphate of lime with the necessary proportion of carbonaceous matter. The phosphorescence of sulphide of calcium was observed and studied by Canton many years ago; but it is only recently that the highly phosphorescent sulphide of calcium, which is used in the manufacture of Balmain's luminous paint, has been prepared. Here is a bottle of the sulphide of calcium in question, and, now it has been charged with light by exposure to the rays of burning magnesium wire, you see how brilliantly it glows in the dark, evolving sufficient light to enable one to read moderately large type by its rays. If this bottle were preserved in the dark, the evolution of light would continue without intermission for more than a fortnight, but with a continually diminishing intensity, so that to see the powder in the dark at the end of the fortnight, one would have to rest the eyes by remaining for some time in a dark place. Supposing that the bottle were kept in the dark for a considerable period, say six months, the stored-up light would not be quite exhausted, as on warming the bottle by immersion in hot water, a considerable evolution of phosphorescent light would take place.

When made into a paint with a suitable oil-varnish, the sulphide loses none of its phosphorescent properties; and articles which have been painted with the Balmain paint remain distinctly visible during the whole of the night, provided that they have received the light during a portion of the day. This circumstance renders the paint of very great value for such purposes as painting posts or gates in dark lanes, the piers of bridges, boats, carts, hoardings, or other objects which may be the cause of accidents in dark places. More than this; a room which is, in great part, coated with the luminous paint is never dark, provided that it receives the daylight for a few minutes during each twenty-four hours. In such a room one may always read letters half-an-inch high; and, if no great time has elapsed since daylight was admitted, it is easy to read small type, such as pica. It is also likely to prove of very considerable value for painting the interiors of railway carriages, as the phosphorescent light renders lamps unnecessary when the route consists of alternate daylight and tunnel. In the case of the paint made with oil-varnish, the sulphide is thoroughly protected against decomposition; but when the powder itself is exposed to damp air, it is slowly decomposed, evolving traces of sulphureted hydrogen.

To give you an idea of the extent with which the phosphorescent paint retains the light, Mr. Barker will hand round a painted card, on which the word "Putney" is inscribed. This card, which has been lent to me by Mr. H. T. Wood, the Secretary of the Society, was exposed in the daylight during this day, and since dusk it has been kept in the dark.

Gas light serves very well to excite the phosphorescent sulphide, and to illustrate this, let me take a tablet one foot square, which has been hanging behind an ordinary gas-burner. This, when handed round, will be found to give quite enough light to enable one to tell the time by a watch; and such a card kept in readiness behind a gas jet, to which it, by the bye, forms a good reflector, might be kept in constant readiness as a safe light for fetching gunpowder, petroleum, or other combustible. The tail end of a train painted with Balmain paint has proved to be even more obvious on a dark night than the usual lamp, and to illustrate this kind of use for the material, Mr. Barker will bring in a wheel which has been painted.

The phosphorescent properties of the sulphide are considerably exalted by the application of heat, it becoming more highly charged while warm, and discharging itself more rapidly. Note the effect of slightly warming this piece of painted canvas, and also notice the curious result obtained when one's hand is placed at the back of the sheet, the heat passing through causing a hand-shaped patch of increased luminosity—in fact, a true thermograph.

Here is another curious experiment. Mr. Barker is sitting in yonder chair, in front of a screen or background painted with the sulphide, and on burning a few inches of magnesium wire a little distance in front, Mr. Barker's shadow is cast on the screen; the shaded portions remaining unexcited, while the general surface becomes luminous. Mr. Barker will now move away, and leave his shadow behind him, like Peter Schlemihl, in Chamisso's well-known story.

Two years ago, when Professor Heaton was lecturing to you on this remarkable substance, it was merely a laboratory product, being manufactured in batches of a few ounces at a time, and at a cost of over twenty shillings per pound; but now it may be regarded as an article of commerce, tons being manufactured now, where pounds were made formerly. There is every reason to hope that, as things progress, the phosphorescent sulphide will be made at as low a price, if not lower, than any other white pigment. The sulphide paint must, naturally, not be laid on the top of any other paint which contains lead, or the black sulphide of lead will be slowly formed. A special neutral base is sold for forming an inert medium between old lead paint and the phosphorescent paint. Through the kindness of Messrs. Ihlee & Horne, of Aldermanbury, each one of you will have the opportunity of taking away a small article painted with the luminous paint. It is said that they have just made arrangements for painting an arch of one of the bridges crossing the Thames.

Another calcium product, which now possesses a considerable commercial importance, and is likely to increase in value, is the blast furnace slag, so long a waste and troublesome by-product. It may be regarded as a crude glass, consisting of lime and clay, only it requires a somewhat higher temperature for fusion than is the case with ordinary glass; but by fusing a varying proportion of sand and soda with the slag, a more useful product may be obtained. The slag, when broken up, makes a rather poor substitute for granite as a road-making material, and blocks or other articles cast of it require a prolonged annealing in order to be of any practical use. A slag product of very considerable interest and importance is the so-called slag-wool, which is obtained by blowing a jet of steam across the liquid slag as it flows from the furnace, the result being a confused mass of fine threads, like wool; but these are intermixed with a greater or less number of minute spheres like small shot.

Slag-wool was first manufactured by the late Mr. Edward Parry, about 40 years ago; but in recent times the manufacture and uses of slag-wool have been considerably extended. One of the most successful works for the production of slag products has been organized by Mr. Charles Wood, who read a paper on this subject before this society rather more than a year ago.

Samples of Mr. Wood's slag products are before you, these having been kindly supplied by the agents, Messrs. Jones & Co., of Kentishtown. Here are samples of the slag-wool, and models to illustrate its use in clothing steam-pipes so as to confine the heat. It is also largely used in order to protect water-pipes from the destructive influence of frost, and to fill partitions in houses, with the view of deadening sound, or preventing the rapid conduction of heat. Here we have a thick and tolerably flexible felt, built up out of the slag-wool, an iron wire network being used to give strength in some instances.

By cooling the molten slag in water it becomes disintegrated, and a kind of sand or shingle is obtained, both these forming an admirable basis for concretes and cements, these uses being illustrated by specimens on the table. When finely ground, the slag sand possesses properties analogous to those of the puzzolana found in Italy, or the trass, which comes from the Rhine districts; and when mixed with a pure lime, it is rendered hydraulic.

The calcium phosphide is a remarkable compound, and it may be readily obtained by passing the vapor of phosphorus over lime heated to bright redness. Here is some of it, and please observe the effect of dropping a lump into a jar of water. The phosphide of calcium becomes decomposed, and the spontaneously inflammable variety of phosphureted hydrogen is evolved, this gas taking fire on the surface of the water. This evolution of phosphureted hydrogen is made available as an indicator, to show the whereabouts of a life-buoy, a small cylinder containing phosphide being attached, and this is perforated or pricked just before the buoy is thrown into the water. In the case of the War Department and Admiralty buoys, the cylinder containing the calcium phosphide is torn open in the act of taking the buoy from its peg. The Board of Trade requires every ship to take one of these buoys bearing a cylinder of phosphide of calcium; but here we find one of those strange circumstances which can only be explained by the general fact of the ways of boards and committees being mysterious and past finding out. *They do not order these buoys to be painted with the phosphorescent paint, although such a buoy would always be visible to those on ship-board, and each flash of the burning phosphureted hydrogen would exalt its luminosity, and render it increasingly easy for the drowning person to lay hold of it.* The oil or varnish form of the luminous paint withstands the prolonged action of fresh or salt water perfectly. The rough model on the table, consisting of a frame of painted card, with a piece of phosphide of calcium tied in a rag at one corner, illustrates this kind of twofold luminous buoy.

It is usual to attach a cylinder containing the phosphide of calcium to the nose of a fish-torpedo, so that, if the mark is missed, there may be a chance of recovering the torpedo. Here, again, the phosphorescent paint might be brought into play, especially as the means of lighting it up is provided.

It is curious to note how the phosphide of calcium and the sulphide of calcium can thus be used side by side for a similar purpose.

The phosphates of calcium have considerable industrial importance, one of these forming the earthy basis of bones. Here is a bone which has been thoroughly burned in yonder gas muffle, and the mineral matter only remains. You see that it is quite white, and retains the external form of the bone. This mineral matter of bones, the so-called bone-earth or bone-ash, consists mainly of the tribasic phosphate of calcium, its composition being

$$Ca_3(PO_4)_2.$$

Not only is this bone earth the ordinary source of the important element phosphorus, but it is used for many industrial purposes, as in making certain kinds of porcelain; and my friend, Mr. Emery, of Burslem, tells me that if cremation ever becomes a general practice, he shall take out a patent for working the ashes of deceased relatives, which practically consist of phosphate of lime, into the material of a porcelain vase, instead of keeping them as a loose powder. Soluble superphosphates of calcium are of great value as artificial manures, and are obtained by treating ground bones with oil of vitriol, and they may be regarded as the tribasic phosphate in which more or less of the calcium has been replaced by hydrogen, as in the following examples:

$$(1.)\ CaH_4(PO_4)_2.$$
$$(2.)\ Ca_2H_2(PO_4)_2.$$

The chloride of calcium is a waste product in numerous manufacturing operations, and notwithstanding that numerous uses have been found for it, the supply is in excess of the demand. It has a remarkable tendency to absorb water from the air, and is consequently largely used in the laboratory for drying air and other gases; and it was proposed at one time to water the streets with a solution of this salt, as, under these circumstances, the roads would remain constantly damp; but this brilliant idea came to nothing, as foot passengers naturally objected to a system which would keep their boots in a chronic state of dampness.

Chloride of calcium crystallizes with six molecules of water, forming crystals, which produce a considerable degree of cold when dissolved in water, and a still greater cold when mixed with snow or powdered ice.

The so-called chloride of lime, or bleaching powder, is largely manufactured by passing damp chlorine over powdered lime. You may consider that it contains a large amount of chlorine locked up ready for action, the release being readily effected by any free acid. This is well illustrated by the process of discharge printing. Here is a piece of madder-dyed cotton cloth, and Mr. Barker will stamp on it some devices with a mixture of gum and tartaric acid. It is next immersed in this bath, which contains chloride of lime and water, and in a few minutes you will find that a thorough bleaching of the red color has been effected where the mixed acid and gum were printed on, the general groundwork of color being unchanged. Either chlorine, or the still more energetic hypochlorous acid, has been liberated on those parts of the fabric which were impregnated with the tartaric acid.

The hardness of water depends on the presence of lime salts, the so-called temporary hardness arising from the presence of carbonate of lime dissolved in carbonic acid; while the so-called permanent hardness is due to other salts of lime. Temporary hardness may be readily removed by the addition of sufficient lime to unite with the excess of carbonic acid, or by boiling; while more complex measures are required to remove soluble compounds of lime in other forms. It was my intention to show you the method of testing water for hardness by means of a solution of soap, and give you some further particulars regarding hardness of water, but time will not admit of it. It will, however, interest you to see a very ingenious apparatus, by which the dirty soft water which flows from roofs during the earlier period of a rain storm, can be led into a drain, or allowed to run to waste, while the clean after-flow is automatically shunted into a fresh channel. This apparatus, known as Buck's rain-water percolater, has been kindly lent by Mr. Roberts, of Haslemere, Surrey. The advantages of a constant supply of clean, soft water, for drinking and other domestic purposes, are sufficiently known to all; but one precaution is necessary. Lead pipes, pumps, or fittings, must be avoided, as soft water acts readily on this poisonous metal, and dissolves a portion as oxide, while ordinary hard water fails to act on it to a dangerous extent.

As might be expected in a short course of lectures on the calcium compounds, the things which have been left out exceed in number and importance those which have been considered. The uniform and uninterrupted success of the experimental illustrations has depended, in great measure, on the watchful care which Mr. Barker has exercised over all the appliances used; and your best thanks, as mine, are due to him in this regard.

* Four lectures delivered before the Society of Arts, London. Lecture 1, in SUPPLEMENT, No. 327; Lecture 2, SUPPLEMENT, 328; Lecture 3, SUPPLEMENT, 329.

RAISING NUTS.—It was stated at the same meeting that a gentleman at the South, while at a dinner party, received news that a vessel had gone ashore with a cargo of pecan nuts, a quantity of which he procured and planted in his garden. He was told he was too old ever to see any fruit from them, but now the trees from these seeds yield from four to five hundred dollars' worth annually, forming a material support for him in his old age. But he has to watch that they are not stolen.

[CONTINUED FROM SUPPLEMENT NO. 325, PAGE 5187.]

SOAP AND ITS MANUFACTURE, FROM A CONSUMER'S POINT OF VIEW.

In our two previous articles under this heading we have considered the subject of hard or soda soaps, showing how they can be easily made by consumers themselves, pure and unadulterated, at a cost generally less than many of the soaps offered to the public, all of which are more or less adulterated. It is a fact that, without exception, they none of them fulfill the conditions of a genuine soap, that is to say, a combination of pure caustic soda, water, and tallow or oil, in the proportion of about 9 per cent. of caustic soda, 60 per cent. of tallow, and 31 per cent. of water, *and containing all the glycerine originally contained in the tallow.* It has been pointed out what an important part this glycerine plays as a lubricant and emollient in a genuine soap, and which is all lost in the old boiling process. This is a point which the writer in a recent article in the SCIENTIFIC AMERICAN, giving a description of the soap boiling process as conducted in a well known soap works in Cincinnati, seems to have somewhat lost sight of. The writer, though ably and clearly describing the purification of the tallow, and its division into stearine for the manufacture of candles, and oleine for the manufacture of soap, passes over the fact that the glycerine by this process is altogether lost, as far as the soap is concerned, which from a *consumer's* point of view is very important. Doubtless in a well conducted soap boiling establishment, by the old method, this loss of glycerine is unavoidable, as it is necessary to heat the tallow and separate the soap to avoid, if possible, the risk of blood poisoning and skin diseases from the use of impure tallow. Recent experiments on germs of disease and blood poisoning, however, by no means render it certain that even a high temperature, and strong alkalies, absolutely remove this source of danger from soap. It is, therefore, much better to make sure that the soap is pure and free from these germs by the consumer, if possible, making his own soap, and taking care that they are not in the soap-making materials to start with, that is to say, by combining pure, fresh tallow, or vegetable oil, with pure powdered caustic soda. This, of course, is quite independent of the important question of the serious depreciation of the soap, by the total loss of the glycerine in the old boiling process, which, as pointed out, is still persistently employed by soap boilers who make soap for *sale*, for the simple reason that a cheaper and impure form of alkali can then be used, and that rosin, silicate, china clay, and other adulterants can be more readily incorporated with the soap, to cheapen its cost, than when the cold process is employed. Naturally, therefore, the cold process, combined with the fact that it puts into the hands of every consumer the means of making his own soap, even on a small scale, is unpopular with all regular soap boilers. That impure and highly objectionable soaps, made by the cold process, are sold to the public is nevertheless an undoubted fact, but this entirely arises owing to the use of impure and cheap caustic soda.

Probably also what has done more than anything else to discredit soapmaking by consumers for actual consumption, is the very impure caustic soda now put up and sold to the public as saponified, or concentrated lye. A careful examination of the so-called "lyes," "saponifiers," and "ball potashes," sold to the public, was recently made by the writer. Some of them were actually found to contain less than ten per cent. of caustic soda, and of the whole range of these articles, only one of them was found of sufficient purity to make soap by the cold process. It may be perhaps fair to state that this exception was the so-called "Lewis 98 per cent. powdered and perfumed lye," which was found to be really what it professed to be, a caustic soda within two per cent. of theoretic purity.

To come, however, to the question of potash soaps, it is an undoubted fact that a soda soap, no matter how pure and well made it may be, can never be equal to a pure potash soap. Potash more naturally assimilates with all animal and vegetable substances than soda. A very notable instance of this is wool. In its natural state, growing on the sheep, it is lubricated and preserved with a kind of fatty compound, consisting of carbonate of potash and grease—no soda being present. Now the teaching of nature in these matters is always correct; therefore it is evident that potash should be used instead of soda in the subsequent treatment of wool, in preparing it for spinning and weaving. This is found actually to be the case, as a wool washed, and the cloth or goods subsequently made from it "fulled," with a pure neutral potash soap, have a softness of handle and a smoothness and silkiness of touch that are in very marked contrast to the same wool washed and the goods made from it prepared with a soda soap. This fact is now beginning to be more generally understood by woolen and worsted manufacturers, who use potash soaps in preparing the wool for spinning, and the subsequent finishing of all fine woolen goods. Even in preparing cotton goods, potash soap is now much more used, although the advantages are not so marked as in the case of woolen fabrics.

Potash soap is far more soluble than soda soap. For this reason, it will wash just as well with cold water as with hot, and it is at the same time more penetrating, therefore it finds its way into the interstices of any article which is washed with it, removing the dirt with much less labor or scrubbing, and also much more quickly.

The difficulty, however, has been in obtaining a suitable potash for the manufacture of a *pure* potash soap, and it is a very much greater difficulty than in the case of soda soap. No soap, either potash or soda, should contain an excess of free or unsaponified alkali. Now in the case of soda soap, even with impure caustic soda, it is possible to obtain a neutral soap, that is to say, a soap containing neither an excess of alkali on the one hand, which is not in combination with the tallow or oil used in its manufacture, nor, on the other hand, an excess of tallow not combined with alkali, and therefore not converted into soap.

When an impure caustic soda is used in the manufacture of soda soap, in order to convert the last traces of tallow into soap, a great excess of alkali has to be used. If this is not done the soap will be greasy and unfit for use, owing to unsaponified tallow remaining in it. Now in the case of soda soap this excess of alkali is removed by the soap boiler by what is called the salting process. When after long boiling the saponification is complete, the soda soap is separated from the excess of caustic lye and impurities, by a quantity of salt being thrown into the boiling pan, which forms a very strong brine. In this brine the soap becomes insoluble and floats to the top, thus separating itself from the impurities and the excess of alkali it contained, which remains soluble and in this brine, and are run off from beneath the soap, together with the glycerine, which is thus unavoidably lost. With a potash soap no process of this kind is possible. If salt were added, by an interchange of chemical equivalents it would convert the whole potash soap into soda soap. There is no substance or process that will render the potash soap insoluble, or separate it from the impurities it contains when made by boiling with Montreal potash or western wood ashes, which are very impure forms of potash, and give a highly impure caustic lye after they are mixed with lime. The whole, therefore, of these impurities must go forward in the potash soap, and the result is, that although as a potash soap it is superior to a soda soap for almost every purpose, yet a soap thus made is utterly unfit for general use, owing to the excess of caustic potash it of necessity contains, rendering it so sharp and strong as to take the skin off the hands if used as a household soap, or destroying the fibers or colors of any table fabric it is used to cleanse.

Now all this is avoided by the use of pure caustic potash in the manufacture of the potash soap, and which is now manufactured and sold in quantity as a commercial article. It can be combined by the cold process with oil or tallow, so as to produce potash soap, with even greater facility than caustic soda; the result being a pure neutral potash soap. It will be evident, as in the case of soda soaps made by this method, if a perfectly pure strong potash lye is combined in proper proportions with oil or tallow, that saponification will be complete, and there will be neither an excess of caustic potash on one hand, or oil or tallow on the other hand, the result being a pure neutral potash soap which cannot be obtained by any other method.

The proper proportions and best means of preparing this neutral potash soap must, however, be described in the next article.

ON THE MANUFACTURE OF CHLORIDE OF SULPHUR.

By J. CARTER BELL.*

THIS substance is now largely used in manufacturing what is called "India-rubber substitute," and though there is a considerable demand for this article, and it is sold by the hundredweight, yet any one consulting the chief works upon chemistry, or the price list of some of our largest dealers in chemicals, would come to the conclusion that chloride of sulphur could only be made in small quantities, and was thus a very expensive chemical to be used on the large scale, for in one list I see the price is nine shillings a pound, and in another list it is six shillings; with large orders, at the prices named, a manufacturer would soon become a millionaire, for the cost of the manufactured article is about threepence a pound.

A friend of mine requiring about half a ton of chloride of sulphur, applied to me for assistance. I consulted all the best works, and they one and all gave the same process, that of passing chlorine over melted sulphur in a retort; this is very well if only a small quantity of chloride of sulphur is required; if it has to be made by the hundredweight this process is impracticable. I therefore had to devise some method which would not require so much care and attention as the above.

For simplicity, I will divide the *modus operandi* into three parts: the generation of the chlorine; drying the gas; passing the chlorine into flowers of sulphur.

Generation of the chlorine: I used a fifteen gallon clay vessel, which was made by the potter specially for this purpose; it had only one aperture, which was two inches in diameter. In having another vessel made, I should prefer to have two holes three inches in diameter, exactly like a two-necked Woulff's bottle; the vessels which are kept in stock have holes four and five inches in diameter, and also have an outlet at the bottom, these holes are inconveniently large, and as the generator is in a water bath, there is a risk of the contents of the jar finding its way into the water. The generator was put into an ordinary iron kitchen boiler, water was put in, and heated by a small fire. Into the generator was put twenty-eight pounds of maganese ore in pieces of the size of a small nut, containing from 70 to 80 per cent. of binoxide of manganese. A carboy of commercial hydrochloric acid was poured in, and the two-inch aperture closed with an India-rubber bung containing a piece of glass combustion tube bent at about an angle of 120°.

Drying the chlorine gas: A Woulff's three-necked bottle, gallon size, may be used. The tubes, if possible, should be ground into the apertures; in default of this, glass combustion tubing and India-rubber tubing slipped over the necks may be used. The sulphuric acid bottle is not absolutely necessary; when it is used, the chloride of calcium will last a much longer period without renewing. The bottle must have a safety tube. The sulphuric acid bottle is connected with a stone aspirator about five gallons in size. An India rubber cork carrying a piece of tubing is put into the inlet at the bottom of the aspirator; the piece of tubing should be pushed through the cork into the vessel a distance of two or three inches. The aspirator must now be carefully filled with chloride of calcium in pieces about the size of small nuts—no powder must be put in; an India-rubber cork carrying a tube must now be put in at the top aperture, which tube is connected with the vessel containing the sulphur.

Passing chlorine into sulphur: The vessels I used were wide-mouthed, blue glass gallon bottles; these were fitted with good ordinary corks. India-rubber must not be used, for the chloride of sulphur acts rapidly upon such corks, making them in a short time unfit for use. It would be better to use Woulff's bottles with ground glass tubes. The bottles are now filled with dry flowers of sulphur, taking care in the filling that room is left for the gas delivery tube. When the bottle is full, a hole should be made to the bottom of the bottle by means of a wooden rod about ¾ of an inch diameter; if this is neglected, and the delivery tube is pushed down through the sulphur, the tube becomes so filled with hardened sulphur that the gas has not a free passage. Two of these gallon bottles are connected together, the outlet tube of number two may be connected with an absorbing apparatus for waste gases.

The apparatus being all connected and gas tight, the water in the boiler may be raised to boiling heat, chlorine is abundantly given off, and after passing through the acid and chloride of calcium, soon begins to act upon the sulphur, which becomes very hot, and abundance of chloride of sulphur is formed, which will be seen in the bottle as a dark colored liquid with undissolved sulphur at the bottom. When the liquor has reached a strength of 136° Twaddle, a new bottle of sulphur may be put in the place of number one; when chlorine ceases to be evolved, the spent acid may be siphoned off, and a new charge of manganese and acid introduced.

Such an apparatus, like the one described, could be fitted up for less than five pounds, and will make at the very least one hundred pounds weight of chloride of sulphur weekly.

* Read before the Society of Public Analysts, on 18th January, 1882.

GAS FOR LIGHTHOUSE SIGNALS.

In a recent lecture before the Society of Arts, London, by J. R. Wigham, after describing the advantages of gas lights for lighthouses, he said:

The great importance to navigation of audible fog signals is now universally admitted. Among those which have been suggested are gas guns. Some years ago, when I was engaged for the Commissioners of Irish Lights in fixing gas-making apparatus at several of their lighthouses, in order that gas might be used instead of oil, as the illuminant, it occurred to me that it would be convenient to use the gas available at such lighthouses for gas guns, as fog signals. With the sanction of the commissioners I fixed gas guns of various sizes at Howth Bailey Lighthouse, and Dr. Tyndall and other gentlemen connected with the Board of Trade experimented with them. The noise of the gas gun is caused by the explosion of a mixture of oxygen and coal gas. We are all familiar with such explosions in the lecture room, but gas guns capable of producing a noise loud enough for a fog signal have only been tried, so far as I am aware, at Howth Bailey Lighthouse.

This mode of fog signaling has a very important advantage, viz., the gun may be fixed at the water's edge, or on a rock in the sea, at a considerable distance from a lighthouse or fog-signal station, and can be loaded and fired as often as required from the station without necessitating the lightkeepers leaving their post, the noise of the explosion and the flash (in itself a good fog-signal) being all the while at the point of danger. It is easy to imagine that such a point, say an isolated rock, might be too small to hold an ordinary gun, and be so inaccessible from the lighthouse, as to render the attendance of a gunner almost impossible.

In order to show how these guns are used, I have fixed one of small size in the far corner of the room, which, for the occasion, we may call an outlying rock, and connected it by an iron tube with this lecture table, which we may call a lighthouse on shore. This gasholder contains the charge, which, of course, is gaseous, and not solid, as in the case of an ordinary gun. So soon as I have loaded the gun—which you will see that I do by simply opening a cock—I apply a light here at the shore end of the tube, by percussion cap or otherwise, and the gun at sea is fired. It will be seen that the explosion very quickly follows the application of the light, so that these guns may be fired at a great distance from a lighthouse or fog-signal station: a gas gun might thus be half a mile long. If the shots are required to succeed each other rapidly, any number of charges may be got ready and successively used. I will now fire the gun which I have loaded.

The gun which you have heard, being simply a piece of tubing, two inches bore by six feet long, has but a feeble sound. The experimental gas guns at Howth Bailey are tubes about eighteen inches bore by nine feet long, and are, as you may well suppose, of enormously greater power. The sound of the Bailey gas gun is about equal to that of an eighteen-pounder cannon, and the cost of each shot of gas is about the same as that of each charge of gunpowder for the cannon.

GAS SIREN.

One of the most important fog signals with which we are acquainted, if not the most important, is the American Siren. It has been well described by Dr. Tyndall, Sir William Thomson, and Sir Richard Collinson, and I only refer to it for the purpose of pointing out that the value of that useful instrument is much increased by its being driven by gas. With gas, at a lighthouse, we are able to set up a most convenient motive-power, requiring neither furnace, boiler, nor stoker, and capable of instant application. The gas engine is by far the best means of driving a siren, chiefly because it may be put into motion in a moment, by the mere application of a match. The advantage of this instantaneous evocation of power can hardly be over-estimated in these days of rapid steam navigation. It is of the utmost importance that, in foggy weather, we should be able to put a powerful sound-signal into full blast at a moment's notice, and this is what can be done with the gas-driven siren. Shipwrecks may take place while we are waiting for the heating of steam boilers or hot-air engines; and if, as I believe is sometimes done, the furnaces are kept always alight, great waste of fuel is of course involved.

One of these gas sirens has been in operation for some years at Howth Bailey Lighthouse. As an example of the efficiency of this plan of working it, I may mention that on one occasion last year it was sounded for fifty-six consecutive hours.* The siren at that important station has given great satisfaction to sailors passing near it in fogs, but I may add intense disgust to the residents on the Kingstown shore, six miles distant, where its unceasing wail is not conducive to sound slumber. Right-minded people, however, rather enjoy this discomfort for the sake of the mariner.

* The great advantage which I claim for this method of working the siren, above all other forms of the instrument with which I am acquainted, consists in this, that from the compactness and simplicity of the arrangements by which it is driven, and from the fact that it is not necessary it should be united, by belt or otherwise, with any motive power, it can be sounded at the water's edge or an outlying rock, or at any position far distant from the station at which the steam boiler or compressed air receiver is situated.

CHLORATE OF POTASH, BINOXIDE OF MANGANESE, ETC.

As the subject of oxygen and its manufacture has been frequently brought forward in these pages during the past few months, owing, I have no doubt, to several serious accidents which have occurred, I again venture to bring it before the notice of your readers.

I have heard many say: "What has oxygen to do with photography?" I think a very satisfactory reply can be given to such a question, and it is this: In the first place, as regards the lantern, it is desirable to have the best possible light that we can get, in order to show off our productions by photography to the best advantage, and, in my opinion, the lime light is the best available means to that end. Now, for enlarging, I do not think sufficient attention is paid to this light. We have at present a great many lanterns after the pattern of the sciopticon for that purpose; but all I have seen do not seem to give a perfectly-illuminated disk, the great drawback being the dark line up the center of the disk, whereas if the lime light were used a most perfect disk would be the result, and I have no doubt many more would use it, only they are a little nervous when it comes to the manufacture of the oxygen, through hearing of so many accidents which have occurred from time to time. Nearly all these accidents have been caused by carelessness on the part of the operator. I have never seen in these pages a *résumé* of any experiments with chlorate of potash and binoxide of manganese, and it is with the view

of giving such a *résumé* I write this article; for if we know the nature of the materials that we are dealing with it places a great power in our hands. It is an old adage that "knowledge is power," and I feel sure it may be applied in this instance; and I am in hopes many will weigh the matter, the result being that it will be the means of avoiding accidents for the future.

I first propose to examine the properties of chlorate of potash. Many are under the impression that chlorate of potash is highly explosive. In this they are greatly mistaken, as the following experiments will show: If we take a large crystal of chlorate of potash and hold it in the flame of a candle or lamp it will not take fire; the surface only melts, and bubbles up, giving off its oxygen. Now, if we take a perfectly clean iron ladle—a small one, such as used by plumbers—and place it over a clear fire or Bunsen burner, having previously put in it some crystals of chlorate of potash, it will be noticed that as the heat increases the crystals will crack and fly to pieces, then fuse, boil, and finally dry up. When boiling, the bubbles which appear and rise to the surface and break consist of the oxygen which is being given off, and after the gas is all given off chloride of potassium only remains.

Again: if we take a clean ladle and make it red hot, and then shoot in some powdered chlorate of potash, it will at once melt and act in the same way as it did in the last experiment. If chlorate of potash itself were explosive or combustible it would at once take fire, but it will not under the conditions I have stated.

Now, we will try what result will be given by the addition of the binoxide of manganese. For this experiment we will take a clean ladle as before (cold), and put in it some coarsely-powdered crystals of chlorate of potash—say about one ounce—and well mix with it twenty-five per cent. of binoxide of manganese, that being one quarter of an ounce. We shall notice that instead of the whole mass melting and boiling it will not go beyond a pasty mass, and keep blowing off in large bubbles, just like boiling thick paste in a saucepan. The addition of the binoxide prevents the chlorate of potash from boiling over, which it would do if in any quantity; and if inclosed alone in a retort with great heat under it, it would boil over out of the head of the retort, whereas the manganese prevents all this, and the gas is given off steadily.

As another experiment we will take a clean ladle, as before, melt in it some chlorate, and drop into it a small piece of paper about half the size of a shirt button, and note the result. As soon as there is sufficient heat the paper takes fire and burns brilliantly while it lasts; and it will be noticed that the chlorate does not take fire in a body, the oxygen given off surrounding the ignited paper supports its combustion, causing intense heat. As soon as the combustible matter is exhausted it goes out, and there is an end of it.

Now, we often hear of the oxygen gas in the retort coming off in sudden rushes or gusts, and sometimes bursting the India-rubber tubes, or disconnecting them. In my opinion the sudden rushes are caused by small particles of paper, straw, or any other combustible matter, being either in the chlorate or manganese; and that is why in a previous article I called particular attention to the care to be taken in removing any foreign matter that may be seen, because if present in any quantity it would be almost sure to take fire at once within the retort. This would cause a sudden increase of temperature, and if the retort be a little weak there is a "bust up," as the Yankees say. If the retort be on a fire and the oxygen happen to blow off from the bottom into the fire the result is something fearful. But if we use a small gas stove instead of a fire, and an explosion from the cause just named should occur—or, again, supposing the bottom of the retort should be weak—the rush of gas, which would naturally be in a large quantity, with great force would blow out the gas, and there would be an end of the matter. This is well exemplified if we turn on a little too much oxygen when using it, and out goes the light. I think I have given sufficient reason for my giving the preference to a gas stove. With the care I take in picking out all foreign matter I can see, I never hear any of those gusts before mentioned, and the gas comes over as steadily as possible.

In a leading article by the editors a few weeks back, notice is taken of my mention of this foreign matter and the question is raised as to how it gets there. I write from my own experience. The chlorate of potash is sent out from the manufacturers in casks, the inside of these casks being generally lined with blue packing-paper placed loosely round the inside. Some of the crystals, after a time, adhere to this paper, and sometimes the paper will get broken up and find its way in among the crystals. Then, again: the wood of these dry goods casks is of a very rough description, and little splinters will detach themselves and become mixed up; so it will be seen I do not blame the venders.

I have mentioned an experiment with the chlorate and manganese. Now if we add a little soot or coal dust, using the ladle again for the experiment; if the quantity be sufficient we shall find that it is a very explosive compound, and to have such a compound in a retort the result would be fearful. We had an instance a few weeks back, of manganese being ground in a job mill—that is, a mill that is used for grinding anything that is required. It has previously been used for grinding coal to a very fine powder to be used for blowing into some kind of a blast furnace; and next came manganese to be ground for oxygen-making, which was soon found out, to the cost of the party who attempted to use it for oxygen-making.

I will here throw out a suggestion which I think might be of value. I am aware there are several very large manganese merchants in the country. They would confer a great boon on the public if they would put up binoxide of manganese in parcels (say) of seven or fourteen pounds, etc., sealed with their label as a guarantee that it is perfectly pure for oxygen-making, and thereby assist in preventing accidents of a fearful nature.

I have known instances of sulphide of antimony being sold in mistake for manganese. It can easily be detected from the former. Manganese is of a brown color when compared with the latter, which more resembles, at first sight, blacklead.

I always test my manganese before I venture to use it, by placing some of it in an iron ladle on a clear fire and making it red hot. If it be pure no small particles will be seen to ignite, but will remain unchanged; if it do this it is perfectly safe to use. Should any small particles in the state of combustion be seen, in such state it will be unsafe to use it. It is best to burn all this combustible matter out, which can easily be done by making the whole red hot and stirring with an iron rod; after this there will not be the slightest danger in using it. I never believe that manganese is adulterated intentionally, as it is far too cheap for that idea to be entertained.

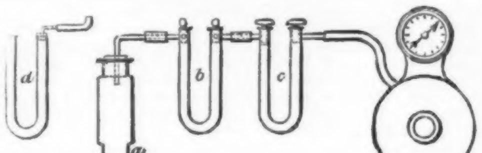
It may be as well to just see, by way of experiment, the result of mixing in a ladle the sulphide of antimony with a little chlorate. To illustrate it only a little must be used. We will put about half a teaspoonful mixed into the ladle and place it over a burner. As soon as it gets warm it flashes like so much loose gunpowder, and the effect may be well imagined if it were inclosed in a retort. If we rub up in a mortar a little chlorate with a few grains of sulphur by means of a pestle, as soon as friction and pressure are applied the whole explodes with sharp reports. But notwithstanding all the dangers I have pointed out chlorate of potash is a very harmless salt in itself.

To sum up: if we see there is no foreign combustible matter in our chlorate, use pure manganese, and see the head of the retort is clear and plenty of gas-way in the tubes and washbottle, not the slightest danger is to be apprehended; and I trust these remarks may be of service to many. I am aware that to *practical* chemists all this is well known, and for such it will not have much interest; but to those who are not versed in practical chemistry my observations may prove of service.—*Wm. Brooks, in Brit. Journ. of Photography.*

THE ESTIMATION OF SULPHURETED HYDROGEN AND CARBONIC ACID IN COAL GAS.

By LEWIS T. WRIGHT.

THE method for the above-named purpose which I am about to describe, is founded upon one described by Fresenius* for the estimation of carbonic acid combined with bases and sulphides which yield sulphureted hydrogen with hydrochloric acid. In adapting it to the purpose of estimating the two chief impurities in unpurified coal gas, simplification of apparatus has been the main object. The principles on which it is based are the absorption of sulphureted hydrogen by cupric sulphate, and of carbonic acid by soda-lime.



The apparatus, which is shown in the accompanying illustration, consists of: One drying cylinder, *a*, for calcium chloride; two U-tubes, 6 in.—one *b*, for anhydrous cupric sulphate, and one, *c*, for soda-lime and calcium chloride, (these U-tubes are preferably those fitted with ground glass stoppers, acting also as stop-cocks); and one ordinary U-tube, one limb charged with soda-lime, and the other with calcium chloride, *d*. A sulphur-test meter will also be required.

The reagents are as follows:

(*e*.) *Calcium chloride.*—There are two kinds sold at the shops—one white, homogeneous looking material should be avoided, as it often contains free lime; the other kind is a dirty porous looking material with acid reaction, and is suited to the purposes of this method.

(*f*.) *Anhydrous cupric sulphate.*—This will have to be prepared by the operator. Ordinary sulphate of copper, roughly broken (not powdered), is dried to complete dehydration at 150° to 160° C. It can first be partially dried at 100° C. in a water bath, and then further dried at about 155° C. in an air bath. Care must be taken not to get it finely powdered. To avoid this, and to procure it in a porous condition, the following method has been used; Dry at 100° C., then slake with a little water, and stir with a glass rod; again dry at 100° C., and then at 155° C. Anhydrous cupric sulphate thus prepared is porous, and offers much less difficulty to the passage of gas than ordinary dehydrated material. The material is highly hygroscopic, and cannot be kept in good condition for very long periods, even when inclosed in well stoppered bottles.

(*g*.) *Soda lime.*—This is sold at the shops and should be tolerably free from carbonates. For use it is crushed and dried.

The drying cylinder, *a*, is charged with roughly broken calcium chloride, *e*; one U-tube, *b*, is charged with the dried copper salt. The objects to be observed are avoidance of "creep" and free passage of gas. Experience will best suggest how this can be done. Small pieces of cotton wool are placed at each end, just under the stoppers, to keep the copper salt in its place. One U-tube, *c*, is to be charged thus: Half-way down one limb place a small plug of cotton wool; over this charge with calcium chloride, *e*, in small pieces like peas, with a small piece of cotton wool just under the stopper; the other portion of the tube to be filled with soda lime, *f*, and a cotton wool plug. Experience will teach how to charge the tube to avoid creep, etc.

The apparatus is fitted together according to the illustration. For connecting the different pieces to one another, of course a certain quantity of India rubber tubing must be used; but the glass tubes should be "butted," and the India-rubber connectors as little exposed to the action of gas as possible, in positions where they are exposed to the action of sulphureted hydrogen, which India-rubber absorbs. This remark does not apply to the junctions after the "copper" tube. In taking off samples of gas to be tested, get as near to the main or vessel to be tested as possible. New iron services are to be avoided until they have had a good quantity of foul gas through them. The service should be fitted with a four way piece and three pillar cocks—one for the gas to be tested, one for blowing a little gas away during experiments, and the other for an ammonia test if such be required.

Having fitted the apparatus together in the following order—drying cylinder, *a*, first; copper tube, *b*, next; then soda-lime tube, *c*, with limb containing the calcium chloride for outlet, and finally the meter—ascertain by trial that all parts are air-tight in the manner usual in such cases. Take off the two tubes, *b* and *c*, turn the stoppers off, remove the India-rubber connectors, wipe the tubes with a dry cloth, and after five minutes weigh the tubes separately, while carefully noting the respective weights. During this operation gas can be blowing away at one of the spare pillar cocks, and also through the drying cylinder, to clear away air and to bring fresh gas along. Having weighed the tubes, place them in their proper positions in connection with the other apparatus. Set the meter to zero. [To counteract "slack" in the hand, finally adjust by blowing through the meter until the hand is just over the mark.] Turn on all the stopcocks, let the inlet of the copper tube, *b*, be the last one turned on, and allow the gas to be tested to pass through the apparatus at the rate of half a cubic foot in 1½ hours, not faster. When the required quantity of gas has passed, shut off the inlet of the copper tube, and then the other stopcocks; disconnect *b* and *c* together, at the junctions between *a* and *b*, and *c*, and the meter. Do not disconnect *b* and *c* from each other. Now connect the chloride of calcium end of the tube, *d*, to the inlet of the copper tube, and a piece of India-rubber tubing, about 2 feet in length, to the outlet of the soda-lime tube, *c*. Open all the stopcocks, and draw air along so as to displace the gas; then close stopcocks, disconnect tubes, *b* and *c*, remove the connectors, wipe and weigh as before after five minutes. The increase in weight of the copper tube, *b*, can be put down as sulphureted hydrogen, that of the soda-lime tube, *c*, as carbonic acid. Calculate the results to grains per cubic foot of purified gas.

The apparatus here described is gauged to about 8 to 10 grains of each impurity. This is in excess of what is usually found in half a cubic foot of gas. Gas made from Newcastle coal contains at the inlet of the scrubbers about 14 grains of carbonic acid and 11 grains of sulphureted hydrogen.

Note.—The sulphureted hydrogen reacts upon cupric sulphate thus:

$$CuSO_4+H_2S=CuS+H_2SO_4.$$

This liberated sulphuric acid no doubt acts upon some of the hydrocarbons of coal gas, forming sulpho-acids. I have found traces of these, but the quantity I believe to be very small. Anyhow, this is a source of error. Any ammonia there may be in the gas is arrested by the calcium chloride drying cylinder, as calcium chloride absorbs ammonia. A trace of carbonic acid is also here absorbed. The calcium chloride should be dried from time to time in a hot oven.

I do not see how sodium or potassium acid sulphates can be used for the gravimetric estimation of ammonia; for the gas to be tested must be previously dried, and ordinary desiccating agents absorb ammonia. I think, however, that they, or some similar salts, might be placed in the bottom chamber of the drying cylinder, in order to absorb any ammonia before the gas reaches the calcium chloride.—*Journal of Gas Lighting.*

* *Vide* "Quantitative Analysis," 7th Eng. ed., pp. 338, 340, 341, 389.

TREATMENT OF AMMONIACAL WATER.

HENNEBUTTE'S PROCESS.

THERE are few industries that give rise to so many secondary products as coal distilling. Yet, for ammoniacal waters derived therefrom, no treatment can be advantageously employed unless the works are of considerable importance. In small works these residues cannot, in most cases, be utilized, because of the expense involved in the installation of special apparatus. The Hennebutte process permits of the manufacture of sulphate of ammonia at slight expense, by using as a reagent, not the somewhat costly sulphuric acid of commerce, but the impure sulphate of alumina called *alum cake*, which is obtained by treating clay with sulphuric acid.

The apparatus for the treatment is very simple, consisting only of a wooden cask which is filled with liquid manure or other ammoniacal fluid. The reagent is added in definite quantity, and the mixture is allowed to stand for half a day, when the transformation of the material in the cask into sulphate of ammonia will be found complete.

The sesquicarbonate and hydrosulphate of ammonia contained in liquid manures, when brought into contact with sulphate of alumina, are brought to the state of soluble sulphate of alumina, while the hydrate of alumina precipitates and carries down with it all the impurities of the liquid. During the operation there are disengaged carbonic acid and sulphureted hydrogen.

After about a dozen hours, the cask may be half emptied by decantation without mixing with the liquid any of the precipitate; since the density of the latter keeps progressively increasing.

When it is desired to obtain hydrochlorate of ammonia, there is used as a reagent a double chloride of calcium and iron, which is obtained very simply by throwing iron ore in powder into a large flask containing hydrochloric acid. At the end of twenty-four hours the iron will be all dissolved and the vessel will contain a very acid chloride of iron. This liquid is then poured into a second flask containing fragments of lime. At the end of twenty-four hours the double chloride thus formed will be ready to mix with the liquid manure to be treated. The sesquicarbonate of ammonia is decomposed, soluble hydrochlorate of ammonia is formed, and carbonate of lime precipitates. The hydrosulphate of ammonia is converted into sulphide of iron, which likewise precipitates, while hydrochlorate of ammonia remains in solution. After a few hours' rest the latter may be easily decanted. The concentration of the salts of ammonia, thus cheaply obtained, may be performed in a sheet iron vat of suitable dimensions by the waste heat from the furnaces. —*Annales Industrielles.*

ROSA GALLICA IN PHARMACY.

THE French have a very old and elegant preparation, originally obtained from the petals of the red rose of Provence—the land of the troubadour and the rose. When it was imported into this country the term *gallica* sufficiently indicated its origin, and while we use the *petals* of the French rose, we employ also the *hips* of our own *Rosa canina*. Both were introduced into the pharmacopœia in the form of confection, as a basis for pills, and for producing an acid infusion of red rose petals (to which a minute quantity of sulphuric acid is sometimes added) proved useful as an astringent.

Roses and honey take us back to our early school-boy days when the cool shade of the pharmaceutical laboratory was generally found preferable to the broiling summer sun of a distant continental city; but we little thought that in the year of grace 1882 we should still find a distinguished French pharmacist writing on an improved method of obtaining *miel rosat*. Such is the case, however, for a recent number of the *Répertoire de Pharmacie* contains a very ingenious paper by M. E. Langlet on this subject. He assures us that the conscientious pharmacist has always been discontented with the preparation as prescribed by the official codex. The long evaporation which we are there directed to make of the infusion destroys the beautiful color of the rose petals, and affects their astringent principle. Numbers of pharmaceutical chemists have endeavored unsuccessfully to remedy this state of things, but at last M. E. Langlet

really appears to have solved the problem, and obtains a product infinitely superior to that of the codex. He takes:

		Parts.
Petals of red roses		100
Water ... 200 parts	of this mixture	200
Alcohol... 20 "		
Ether. ... 20 "		

The dried rose petals are broken into a powdery condition and the liquid mixture poured upon them, the whole being allowed to remain thus for about three hours. The mixture is then placed in a press, and, after pressing, 600 parts of boiling water are poured on to the residue (the pressed out liquid obtained in the first place being kept cool meanwhile). After the boiling water has acted for three hours, let it pass through with slight pressure only, and clarify this product with white of egg. It would be preferable to filter it through paper, but as it soon obstructs the pores of the paper and so filters very slowly, the author prefers clarifying with the white of an egg, more especially as the greater part of the tannin has gone in the first pressed out portion, together with the coloring matter.

The watery solution obtained in this second operation is rapidly evaporated at a moderate temperature until it is reduced to 150 parts, and to this is added pure white and hard honey 600 parts. Bring the mixture quickly up to boiling temperature and then add it at once, a little at a time, to the ether-alcoholic solution set aside in the cool. When the mixture is complete, heat for a few minutes without boiling, until all the ether in the mixture has evaporated, allow the liquid to cool, and filter through good porous filtering paper

The product thus obtained is truly beautiful; it has a fine red color, an odor of roses, and its flavor is that of the pure rose petals.—*Monthly Magazine.*

THE ADULTERATION OF DRUGS IN AMERICA.*

By FREDERICK STEARNS.

THE Committee on Adulteration of Drugs offer the following as their report:

Prior to writing the report the chairman sought, from members of the association, by circular, whatever information upon the subject each member might have to offer. The order followed in arranging this report is: first—to give the new forms of adulteration noticed in those journals to which the writer has had access during the past year, together with the means, when given, for determining the same; second—recent legislation against adulterating food and medicine; third—suggestions, criticisms, and comments bearing upon the subject.

ADULTERATIONS.

Glucose.—Eleven millions of bushels of corn will be used this year in the twenty glucose factories of the United States in producing this product, most of which is employed for adulterating cane sugar and cane sirup. This amount of grain is equivalent to over one thousand car-loads per day, and when it is to be considered that the principal temptation to its production is, so far, its fraudulent use as an adulerant for true cane sugar, not easily detected, enabling the producers to reap fabulous profits therefrom, the writer thinks that it is high time that State or national legislation should compel manufacturers and mixers of this left-handed, often impure, insipid sugar, to brand it, whether pure, or mixed with cane sugar, by its right name and percentage, that buyers may get what they pay for. At the last meeting of the American Pharmaceutical Association, Mr. Allaire, of this committee, very properly reported against the use of glucose in making medicinal sirups as a substitute for cane sugar.

Japanese Star-Anise.—Mr. Kelly, of this committee, through the kindness of Stallman & Fulton, New York, reports (with accompanying specimen) upon this article, stating that there was an arrival in New York of about fifty cases, which were, it is believed, afterwards exported to London. It was offered as low as ten cents per pound. An exhaustive article on this drug appears in *New Remedies*, July, 1881, pages 199 to 202 inclusive, which is appended to this report. A synopsis of the same may be stated as follows: The genuine star-anise is a product of Cochin-China and Siam, while the false star-anise comes from Japan, both belonging to the genus *Illiscinni* of the N. O. Magnoliaceæ. The botanical difference in the fruit of the two is so slight as to easily deceive upon superficial examination. In taste the genuine is sweet and anise-like, the odor faintly like anise. The taste of the false is disagreeable, and not sweet or anise-like, its odor different from anise, faintly resembling laurel, camphor, and nutmeg. The genuine is somewhat larger than the false, its surface more cork-like, points short, horizontal, or slightly curved upward, further separated carpels, less woody, shrunken, and wrinkled; seeds mostly dark-brown, with rounded point. Surface of the false fruit more shining and red brown; points thin, often strongly curved upward; carpels more woody, greatly shrunken, and wrinkled; seeds mostly yellowish brown, with strong raphe and elevated point. This false star-anise is considered highly poisonous in its native habitat, and analyses by the sanitary authorities of Japan have isolated a crystalline principal as highly poisonous. Whether the genuine star-anise contains an identical poison in smaller proportion remains yet to be determined. Your reporter thinks it not at all improbable, for reason of the profound physiological effects of the proximate principal of the Japan star-anise, that it may in the near future become a valuable addition to the materia medica far exceeding in therapeutic value the variety which this specimen is vainly wandering around the world to substitute.

Cubebs.—The present high cost of this drug, owing to its increased use for smoking in catarrhal cigarettes, has led to fraudulent practices. The writer has recently had offered to him crushed cubebs from which the essential oil had been mostly removed by distillation.

Antimony Sulphuret.—Your reporter has seen this article offered, consisting entirely of ground, broken crockery, and anthracite coal dust.

Cascara Bark.—This new drug, the product of *Rhamnus Purshiana*, has come largely into use since its introduction to the medical profession by Parke, Davis & Co. Through the ignorance of collectors it often occurs, and has occurred repeatedly to your reporter, that large parcels of inert and worthless bark and barks of allied species are offered in place of genuine.

Mixtures.—Mr. Allaire, of this committee, reports that twice during the past year mixtures prepared for adulterating powdered drugs were offered him. He failed to obtain samples for reasons that he could not get them in less than five barrel lots. They were of three colors, red, yellow, and brown. They were offered him at 2½ to 4 cents per pound.

Jalap.—Mr. Allaire has made several examinations of commercial powdered jalap, showing that not over 10 per cent. of the samples were up to standard. In regard to jalap, your reporter sees no reason why it should not have its market value and price established by the proper assay of each lot, as in the case of opium and cinchona.

Spruce Gum.—Your reporter detected an ingenious substitution in a lot of this article; his suspicions were excited by the fine appearance of the lot. It proved to consist of artfully prepared lumps of common resin, mixed with a small per cent. of the genuine gum, the whole being roughened by attrition.

Oil of Bay Rum.—Your reporter is informed that the so-called "smuggled" oil of bay rum is nothing but the genuine oil mixed with the oil of clove and oil of pimento, and in this condition artfully foisted upon unsuspecting parties at a price less than the imported and duty-paid oil can be sold, under the pretext that it is probably "smuggled."

Oil of Bitter Almond. (*Ess.*)—In order to introduce into market the oil now made by synthesis, and which, while it has the chemical formula of its natural analogue, is unlike it somewhat in odor, and showing strong signs as it does of its derivative, is branded "German Oil."

Oil Ylang Ylang.—The recent great reduction in the price of this fine perfume leads to the suspicion that the reason for it lies in some ingenious sophistication not yet determined.

Ginseng.—Lilienthal Bros., of New York, report being imposed upon by ginseng fraudulently mixed with a root so closely resembling ginseng as to defy detection, unless every root was carefully broken for examination. They also found leaden plugs inserted in genuine root to add weight to it.

Rose Leaves.—Mr. Greenish (London Pharm. Soc.) calls attention to artificially-colored rose leaves, common in the London market early this year. They prove to be petals of the pale cabbage rose, *Rosa centifolia*, artfully dyed with coraline, or rosaniline, and dipped in perfume. They prove to be of German origin, and shipped from Hamburg to the amount of from one to three thousand pounds.

Oil of Peppermint.—J. J. Quetting & Co., New York, report finding much of this oil adulterated with oil of pennyroyal, and give as a reliable test a solution of two parts of chloral in one part of sulphuric acid, to which is added 5 per cent. of alcohol. The test mixed with the suspected oil in equal proportion gives a fine cherry color to pure oil, and a dark, olive-green if mixed with pennyroyal.

Olive Oil and Cotton Seed Oil.—Our consul at Naples, the Hon. B. O. Duncan, reports to the State Department that immense quantities of refined cotton seed oils are imported into Italy for the special purpose of sophisticating the native oil, for reason that it can be laid down in Naples at less than half the cost of producing pure olive oil. Hence the temptation is great to use it for mixing with pure oil for export from Italy to other countries. Its use is not easily detected except by chemical means. G. A. Buckheister (*Droguisten Zeitung*) finds that while the ordinary tests, sulphuric and nitric acids, potash, lye, ammonia, etc., produced no definite reactions, he could, by a mixture of equal parts of sulphuric and nitric acids, render visible as small an addition of cotton seed oil as ten per cent. Three parts of this test to ten parts of the suspected oil is shaken together. Pure oil gives a white color with a greenish cast, that mixed with sesame a grass-green, and that mixed with cotton oil a paler color. After a few minutes the liquids separate, and pure olive oil appears almost unchanged; cotton seed oil a light brown.

Wines.—(New York *Times* Paris correspondence). Out of 123 samples of wines examined at the new laboratory at the Prefecture of Police, Paris, only three were found genuine grape juice; the remainder were falsified

Logwood.—*Le Teinturier Pratique* notes complaints about the adulteration of this dyewood with inert substances, such as molasses, sawdust, clay, etc., re-enforced by sumac and chestnut extracts.

Oil Wintergreen.—Is adulterated with alcohol and chloroform, and also with oil sassafras. The first two may be detected by fractional distillation. Chloroform will make itself evident on warming a sample of suspected oil. Strong nitric acid will detect oil of sassafras, turning the sample red, and throwing down a dark resinous mass. In pure oil this test leaves the oil unchanged for some time, and finally deposits white crystals of methyl-nitro-salicylic acid. A second method is to distill from the sample the chloroform—generally added with the sassafras to give the correct specific gravity; add to the residue one fourth its weight of potassium hydrate solved in four parts of hot water, when the odor of the sassafras will be apparent.

Potassium Iodide.—Kasper (*Schweiz. Woch. Pharm.*) has investigated commercial iodide of potassium as to its purity, and determines it by its reaction with corrosive sublimate, a simple and easy test. His conclusions are that in the commercial state the pure salt varies from 88 to 99½ per cent.; that it should contain from 96 to 97 per cent. pure salt.

Red Cinchonas.—R. V. Mattison (*New Remedies*, October, 1881) gives the analysis of 20 specimens of commercial red barks, and states that four-fifths of the so-called red barks are nearly or quite devoid of crystallizable alkaloids; that the commercial red barks rejected by the quinine makers are absolutely worthless—that it is never a *true red* bark. No rich barks can be had at a low price. This explains why Huxham's tincture is so often found worthless, and why it is so much better when made from the popular fluid extract, for the reason that the manufacturer has to use care in making his choice of material. Out of twenty analyses, the commercial barks yielded from nil to traces, and in one instance only nearly a half per cent. quinia; of cinchonidia, etc., from nil to one and six-tenths of one per cent.; of cinchonia, etc., from nil to three per cent.

Silicate of Soda.—This has long been used as a dilutant of laundry soaps. Now the French journals announce that the silicate itself is adulterated with soap, added for the purpose of giving it a deceitful gelatinous appearance.

Salicylic Acid.—Adulterants of this salt are mentioned (*Drug. Circular*, September, 1881) as sugar, acid sulphate of potassa and cryst. sulphate of lime, starch, and silica, and as accidental impurities due to imperfect washing—carbolic acid, muriatic acid, and soda salts.

False Chian Turpentine.—This drug, in its purity, has probably not existed in market to any extent at all for many years.

Linseed Oil.—Mason (Report to Liverpool Chemists' Association) says 250 tons of this oil, adulterated with neutral petroleum oil, has been sent from that port to foreign ports; that it contained about 30 per cent.; that the test is its specific gravity, and the separation of the adulterant made by converting the sample into soap, and washing this with petroleum spirit, which readily removes the mineral oil, which does not saponify.

Benzoic Acids.—Gehe states that hippuric benzoic acid is now made from urine of cows as well as that from horses, and when so made has less characteristic odor; and further states that toluol benzoic acid is now in market at various grades and prices. Bedford (Proc. N. Y. State Pharmaceutical Association) states the latter has a strong odor of its derivative—nitro-benzole; and that of the imports of the past year—8,500 pounds—over 5,000 pounds of this was the urine-benzoic acid. Permanganate of potassium, added to a solution of benzoic acid neutralized with carbonate of sodium, is discharged if the benzoic acid is that from urine, but if from gum it becomes green.

Solution Citrate Magnesia.—Classen (*New Remedies*, October, 1881) traces the reason why there is no precipitate in this solution, as made by a popular New York manufacturer, to the fact that it has no magnesia in it, but consists of sodium tartrate.

Orange and Lemon Oils.—It is reported that the cheapness of ess. oils orange, lemon, and bergamot, made in Messina, Italy, is not so much due to the use of improved methods and apparatus as it is to a way they have of rectifying the French spirit of turpentine, and obtaining a fragrant non-oxidized product from it that admits of free admixture with the ess. oils without ready detection.

Essential Oils Adulterated with Alcohol.—Drechsler (*Zeitsch. f. Anal. Chem.*) employs a test—a solution of potassium bichromate, one part, in nitric acid (sp. gr. 1·30) ten parts. Alcohol is betrayed by the odor given off of ethyl nitrate.

Bismuth Subnitrate.—Vitali (*Bulletino Farm.*) reports meeting this contaminated with calcium phosphate as an adulterant.

Coriander Ess. Oil—Bergamot Ess. Oil.—Both are adulterated with colorless rectified oil orange, on account of lower cost of the latter, and may be detected by its insolubility in 95 per cent. alcohol. The pure oils dissolve in all proportions; the mixed ones make a turbid mixture.

Caraway Seed Oil.—Is adulterated with ess. oil derived from caraway chaff, and this chaff oil is first mixed with rectified spirits of turpentine. This can be detected by the same test as foregoing.

Saffron.—Grispo (*Jour. Phar. d'Anvers*, February, 1881) has analyzed a factitious saffron, and found vegetable filaments of unknown origin, with water, glucose, and baryene. Kanoldt (*Pharm. Ztg.*, No. 34) has examined a factitious saffron that consisted entirely of an alga, probably *Fucus amylaceus*, which had been weighted with a colored mixture of chalk and honey.

Beeswax Adulterations.—Jean (*Chem. Zeitung*, No. 34) recommends the following tests for wax:

For water—Knead the wax with well-dried copper sulphate, which will give a blue color.

For mineral and starchy matters—Solve in turpentine; these remain unsolved.

* Read at the Seventh Annual Convention of the Western Wholesale Drug Association, New York.

THE PHYSIOGNOMY OF CONSUMPTION.*

THE idea that a certain type of face indicates a tendency to certain diseases is not only widely diffused in the medical profession, but among the public at large, as is shown by the frequent occurrence of such phrases as "consumptive-looking," and "apoplectic looking." With a view to ascertaining how far these generally-entertained ideas are true, and of substituting for mere personal impressions the test of exact and unprejudiced investigation, the authors of this paper have made a number of observations by the method of composite portraiture, already described by Mr. Galton in *Nature*. The countenance which is supposed to indicate a tendency to phthisis or consumption, is one of the best marked and most commonly recognized. The authors have begun with this disease, and at present have limited themselves to it. A large number of portraits of phthisical patients were first taken, and were then grouped into composites, clinical facts being first taken as guides for grouping. Thus, cases of advanced disease were grouped first, but they gave no result beyond that of well-marked emaciation. Cases grouped according to the rapidity of their course also yielded no characteristic type, nor was anything very definite at first obtained from those in whom the hereditary taint was strong, but on further investigation this last group of hereditary cases was found to fall into two main divisions, not separated by any abrupt line of demarkation. In the first division the faces were broad, with coarse, blunted, and thickened features; while in the second the faces were thin, narrow, ovoid, with thin, softened, and narrow features. These two groups correspond to the two types well recognized by physicians as strumous and tubercular. On comparing the phthisical with non phthisical cases, however, it was found that the percentage of narrow ovoids was almost exactly the same in the phthisical and non-phthisical patients. Although the authors do not say so, we may perhaps be justified in regarding these two types of face as possibly radical. Their results lend no countenance to the belief that any special type of face predominates among phthisical patients, nor to the generally entertained opinion that the narrow ovoid tubercular face is more common in phthisis than in other diseases. Whether it is more common than among the rest of the healthy population, they cannot at present say. In comparing composites, both of the broad faces and of the narrow ovoid faces in phthisical and non-phthisical patients, they found that in each case the phthisical patients presented a more delicate form of each type, with finer features, a lighter lower jaw, and an altogether narrower face. Although their conclusions seem to indicate that there is no foundation for the belief that persons possessing certain physical characteristics are especially liable to tubercular disease, yet it may hereafter be proved that some explanation of the doctrine may be found in the course of the disease when it attacks such persons.

Thus the delicately-organized individuals called "tubercular," and characterized by their "narrow ovoid" faces, have been compared with horses and cattle who have been what is called "over-bred;" such animals are described as having too much nerve and too little bone and muscle; they have no "staying power," and readily "knock-up." So these delicately formed individuals are less able to stand the strain of disease and are more liable to its attacks than their more robustly-built fellows. Again, if it be true, as frequently asserted, that those having the features called "strumous" probably inherit a more or less diluted syphilitic taint, it is not surprising that they should be especially liable to inflammatory changes of a low type, and that disease in them should be readily amenable to treatment, especially by mercury, a result commonly seen in the so-called "strumous diseases of children and often in those of adults."

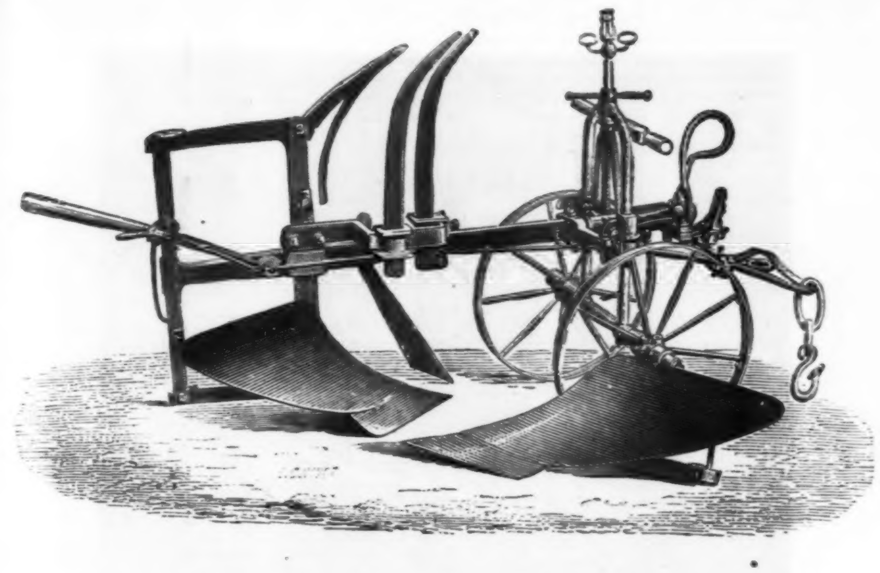
This paper opens quite a new field of inquiry which is of great interest, and is likely to lead to important practical results.—*Nature.*

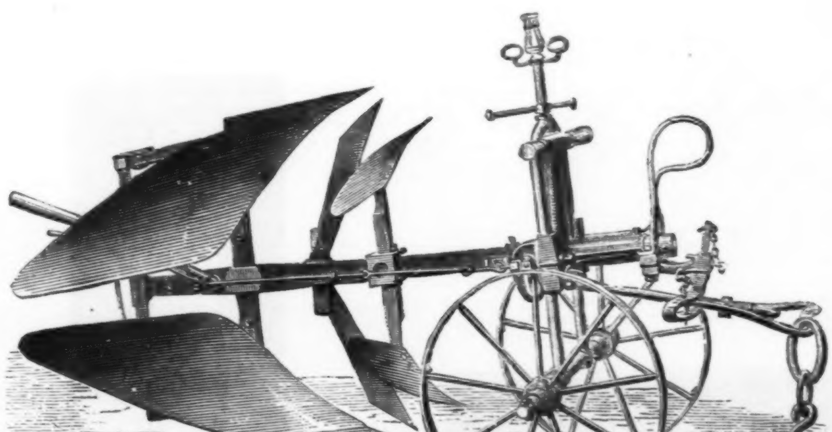
* "An Inquiry into the Physiognomy of Phthisis, by the Method of Composite Portraiture." By Francis Galton, F.R.S., and F. A. Mahomed, M.D.

FONDEUR'S IMPROVED PLOWS.

WE give in the annexed cuts illustrations of three types of French plows on the Fondeur system. The improvements that this manufacturer has introduced into the double plow and the advantages that be claims for his implements are as follows: First—The use of steel on a large scale, all parts into which that material can be introduced with advantage being constructed of it. The cast-iron parts, instead of being of ordinary cast iron, as in all other plows, are of malleable cast iron or of cast steel. The bearing, for example, which plays so great a role in the implement, is here of cast steel. The forecarriage of this plow, although appearing complicated at first sight, is wonderfully simple. The regulator moves in a slot pierced with small holes and is stopped by means of small pins. It may be depressed at will in order to modify the line of traction and to cause the implement to penetrate the stiffest soil. The regulation may be effected instantaneously, and a person without any experience whatever in the use of the plow can manage it without any prior instruction. All nuts and screws, the presence of which are great drawbacks to a plow which is to be put into the hands of inexperienced persons, are here done away with. The excellent mould-board of this plow is one of the prominent features of the implement. It is of an elongated form, and its shape is such that it permits of turning the slice of earth at an angle of 45° and of bringing the subsoil completely to the surface. Moreover, it divides and disintegrates the earth so well that the subsequent passage of the harrow is rendered very easy. The turning of the furrow is effected so easily that we are led to think that there is less adherence in this form of mould-board than in the helicoidal. Furthermore, the traction is reduced to a minimum; and this is proved by the ease with which the horses do their work when the plow is operating with regularity. This system of mould-board is now being adopted on all kinds of plows, in all those countries into which Mr. Fondeur's implements have been introduced. Of the shares and colters we shall only remark that they possess the best possible arrangement that could be given them. Finally, the implement as a whole is well proportioned; and its simplicity is such as always to render it easy of repair by the owner. What has just been said about the double plow with alternating shares, applies equally well to the Fondeur double drain plow, which is an implement of the same type; although the latter is distinguished from the former by an apparatus arranged at one side of it, designed for turning up the earth from a great depth with the exertion of but little power. The drain plow as an agricultural implement has long existed, but it has never hitherto been adapted to an ordinary double plow in a so thoroughly practical manner as it has here. Upon a stirrup-shaped iron, which is firmly connected to the colter and follower, there are mounted two very strong steel teeth, one in front and one at the side. In addition to these there is a third tooth which protects the colter against wear. These together form a triangle which takes in the whole width of the furrow laid open by the share and mould-board. The whole surface of the field is thus dug up. This plow is now in extensive use in France among cultivators of the beet.

The third type represented in the cuts is a double two-share (*bisoc*) plow, which is capable of plowing in either direction, throwing the earth to the right or left, and changing furrow without any loss of time. With four horses and one man it will easily prepare two acres of ground per day. It is as easily managed as the double plow, and is regulated in the same way.—*Pantheon de l'Industrie.*

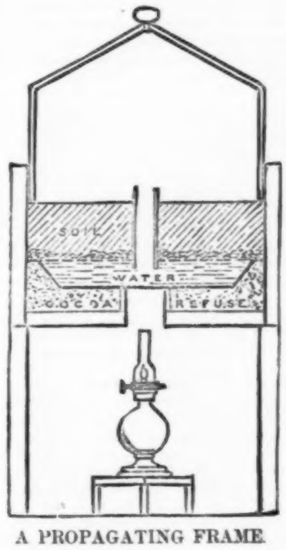




A PROPAGATING BOX.

A LADY furnished the *Gardener's Chronicle* a detailed account of her contrivance for starting seedlings in winter, or early spring, in place of a hot-bed, which appears to possess practical merit, and the substance of which we copy. It might be used for tomatoes and other early vegetables, as well as for many flower seeds.

A stout wooden box was made about 20 inches square and about 18 inches deep. This was supported on four legs, a hole was made in the bottom and boxed round; then about 2 inches of cocoanut refuse was placed over the bottom of the box, and packed round a common tin baking dish; on this were placed two or three strips of wood to support a sheet of perforated zinc with a hole in it through which was let in a common 2-inch draining pipe in a vertical direction, so as to enable water to be poured into the dish. Over the zinc cover was a layer of broken pottery, and over that a quantity of fine sandy soil, filling up the box to within 6 inches of the top. An ordinary square garden hand-light, with upright sides and pyramidal top, was put over the whole apparatus, and a lamp was placed under the hole in the bottom of the box.



A PROPAGATING FRAME.

The seeds were sown in small pots, which were sunk in the soil to a greater or less depth, according to the amount of heat which they required. The steam from the hot water passed through the holes in the zinc, and kept the soil moist and warm, raising the temperature at the surface to about 70° Fah. Of course the water in the baking-dish required to be renewed to replace the loss occasioned by evaporation, and a little practice soon taught how often this should be done. As the frequency must depend on the depth of the baking-dish, etc., each experimenter must ascertain for himself, by occasionally putting a stick down the draining pipe and noticing the depth of the water below; for if by carelessness he allow the water to entirely evaporate, a hole in the tin will be the result.

As the young seedlings grew it became necessary to provide more room for them in a longer box, or one two feet wide and four feet long, not heated with a lamp, but with a special tank to be filled with hot water every 24 hours, and with a tap for drawing off the water which had cooled; and a bent pipe at the side for filling it, which being no higher than the top of the tank, prevented danger of overfilling. It was covered with sliding lights. This box not being so warm as the other, answered well for receiving seedlings already started.

ST. VITUS'S DANCE AND SENSITIVE PLANTS.

WE have constantly new illustrations of the identity in structure between plants and animals, and the close analogy, sometimes amounting to identity, in the life history of the two. One of the latest attempts in the direction is that of Dr. Warner, the lecturer on botany at the London Hospital, who essays to show that the movements of sensitive plants are analogous to those so-called nervous movements more or less unconsciously and unwittingly made by unhealthy children.

The following note is taken from the *British Medical Journal:* "Those planted in a soil of two parts of decayed vegetable mould to one of sand, grew more vigorously both in height and foliage than the others; and after two months, growth they were much less sensitive than others planted in two-thirds of silver-sand and only one-third of leaf-mould. One or two plants were grown entirely in silver sand. These showed extreme sensitiveness to the slightest touch; even a breath of air, or the slightest jerk of the pot in which they grew, caused all the foliage to shut up. Those plants having no nourishment beyond the gases in the air or sand soon turned yellow and died. The plants in two-thirds sand and one-third decayed vegetable mould were not so robust or strong as those grown in a greater proportion of vegetable mould. They failed to produce any flowers, and died off at the lowest temperature to which all the plants were exposed; while those planted in two-thirds vegetable mould and one-third sand fully matured their growth, flowering in a temperature of 50° or 60°, the foliage being of that full green color denoting the fact that the spongioles of the roots had necessarily been supplied with the various chemical gases in the soil (set free by a due amount of moisture) requisite for producing the continued support of the plants."—*Gardener's Chronicle.*

AN ANTHROPOMORPHOUS LEMUR.

THE stock from which the true quadrumana have been derived is supposed to have been in the lemurs, but no type of that sub-order has hitherto been found which presents any near resemblance to either of the four families of monkeys. The two inferior families, *Cebidæ* and *Hapalidæ*, agree with most of the *Lemuridæ* in having three premolar teeth, but those of the upper jaw generally have well developed internal lobes like the true molars, while most of those of the Lemurs have none. One group of Lemurs, the *Indrisinæ*, agree with the higher monkeys in having but two premolars, but these also are only one-lobed.

A nearly perfect cranium of a species of *Anaptomorphus*, Cope, shows that this genus had but two premolars in the superior series, as in the *Indrisinæ*, but that they are two-lobed, as in the *Simiidæ* and *Hominidæ*. Of these two families, the *Hominidæ* is the one to which *Anaptomorphus* makes the nearest approach in dental characters. The canine is small, with a crown little longer than those of the premolars, and is not separated from the latter or from the incisors by any appreciable diastema. All but one of the superior incisors are lost from the specimen, but those of the lower jaw, which I discovered in 1872, were nearly erect, as in man and the *Simiidæ*, and not procumbent as in most Lemurs. The cerebral hemispheres are remarkably large for an Eocene mammal, extending to between the middles of the orbits; the interior parts, at least, are smooth. The cerebellum is projected beyond the foramen magnum posteriorly, as in *Tarsius*. The orbits are large, approaching those of *Tarsius*, but are not so much walled in by a septum from the temporal fossa as in that genus. The superior molars have only one internal cusp.

The species, which I propose to call *Anaptomorphus homunculus*, has a wide palate, much as in a man, and the true molar teeth diminish in size posteriorly. The pterygoid and zygomatic fossæ are short and wide, and the petrous bone is large and inflated. The animal was nocturnal in its habits, and was the size of a marmoset. The genus is nearer the hypothetical lemuroid ancestor of man than any yet discovered.—*E. D. Cope, in American Naturalist.*

PRUNING TREES.—The owners of young orchards should bear in mind that there are four modes of pruning young trees, namely—nipping off needless shoots when green, with the thumb; secondly, cutting off one year shoots with a pocket-knife; thirdly, sawing off small limbs; and fourthly, sawing off heavy limbs which have grown out of shape and distorted the tree. By the first, taken in time, the tree may be trained to perfect symmetry, with no mutilation; and each successive one following is more objectionable and worse.—*Country Gentleman.*

COMETS.

By RICHARD A. PROCTOR.

THE year which was to have seen the end of the world, because of planetary conjunctions and perihelion passages, because Mother Shipton had said so (or was said to have said so), and because the ascending gallery in the Great Pyramid is 1,882 inches long (so that the year 1882 is to introduce a new era), has been remarkable in astronomical annals for the number of comets which have been seen. Already six have been numbered, and the year is not over yet. Something still remaining—more, indeed, than we are always ready to admit—of old superstitions respecting comets, has led many to regard the coincidence as full of meaning. Others, not quite so credulous, have supposed that though comets may not come in flights of half a dozen together to portend the end of the world, they may yet affect our weather in some way; perhaps directly, as the moon is supposed to do (with very little reason), perhaps indirectly, by acting on the sun. To the astronomer the appearance of so many comets—some of them large ones—has been full of interest, because he hopes by the application of the new methods of research discovered within the last quarter of a century to solve some of the mysteries with which the whole subject is still fraught, despite a number of interesting discoveries which have recently been made.

A brief inquiry into some of the facts which have been discovered respecting comets, and a discussion of some of those peculiarities which still remain among the greatest mysteries of science, will probably prove acceptable at the present time, when comets attract so much interest and attention.

Elsewhere in the solar system we meet with relations not differing greatly in kind from those presented by our own earth. We see a set of globular bodies revolving around the sun in nearly circular orbits, nearly in one plane, and all in the same direction; we find that these globes rotate upon their axis—still in the same direction; they have, apparently, atmospheres proportioned to their dimensions; and many of them are attended upon by bodies resembling our own moon. And therefore, without entering upon the vexed question of the plurality of worlds, we are able to pronounce that, *if* these globes are inhabited, dwellers upon them have, like us, their years, their days, their seasons; a sun—rising in the east and setting in the west; twilight and moonlight; air and vapor; winds and rain; all things, in fact, as it would seem, necessary to their comfort and convenience. Here and there—as in the zone of asteroids and the rings of Saturn—we meet with novelty of arrangement or configuration; but even then we find a stability, either of figure or motion, which renders such objects comparable, so to speak, with those we are accustomed to.

But with comets the case is wholly different. When we have said that these objects obey the law of gravity, we have mentioned the only circumstance—as it would appear—in which they conform to the relations observed in terrestrial and planetary arrangements. And even this law—the widest yet revealed to man—they seem to obey half unwillingly. We see the head of a comet tracing out systematically enough its proper orbit, while the comet's tail is all unruly and disobedient.

The paths followed by comets show no resemblance either to the planetary orbits or to each other. Here we see a comet traveling in a path of moderate extent and not very eccentric; there another, which rushes from a distance of two or three thousand millions of miles, approaches the sun with ever-increasing velocity until nearer to him than parts of his own corona (as seen in eclipses), sweeps around him with inconceivable rapidity, and makes off again to where the aphelion of its orbit lies far out in space beyond the most distant known planet, Neptune. Some comets travel in a direct, others in a retrograde, path; a few near the plane of the earth's orbit, many in planes showing every variety of inclination. Some comets regularly return after intervals of a few years; some after hundreds of years; others are only seen once or twice, and then unaccountably vanish; and not a few show by the paths they follow that they have come from interstellar space to pay our system but a single visit, passing out again to traverse we know not what other systems or regions.

The ancients believed comets to be of the same nature as meteors, or shooting stars—either in the earth's atmosphere not far above the clouds, or, at all events, much lower than the moon. These views are, however, much less ancient than the more correct views maintained by the Pythagoreans. Their doctrine was that comets are planetary objects, having long periods of revolution. From whom this opinion was derived is uncertain. Like other opinions attributed to Pythagoras, it was doubtless obtained from Eastern philosophers; but of what country—whether Egyptian, Persian, Indian, or Chaldean—we have no means of learning. Apollonius, the Myndian, ascribes the opinion to the Chaldeans. He says they spoke of comets as of travelers penetrating far into the upper (or most distant) celestial spaces. Seneca and Pliny held similar views, exhibiting in this respect, says Humboldt, the imitative faculty of the Romans. But the Greek philosopher preferred to look for a theory of the universe in the conceptions of his own brilliant and imaginative mind. As if to show future ages how little was likely to be achieved by the highest mental powers without the habit of patient observation, he endeavored to educe a system of philosophy from fancies, and to found it upon syllogisms. Aristotle—who may be considered the typical philosopher of the Greek school—included comets in the wide range of phenomena which he claimed the privilege of explaining. To him was due the opinion mentioned above—an opinion confidently maintained during the many centuries in which the philosophy of Aristotle held sway over men's minds. To him, also, was due a yet more remarkable opinion, the view, namely, that the Milky Way is a vast comet which continually reproduces itself! Xenophanes and Theon, in the fifth century, adopted a rather singular view of the Aristotelian theory of comets, when they spoke of these objects as "traveling light-clouds."

FIG 1.—VARIOUS FANCIFUL VIEWS OF COMETS, ACCORDING TO PLINY. From the *Cometographia* of Hevelius.

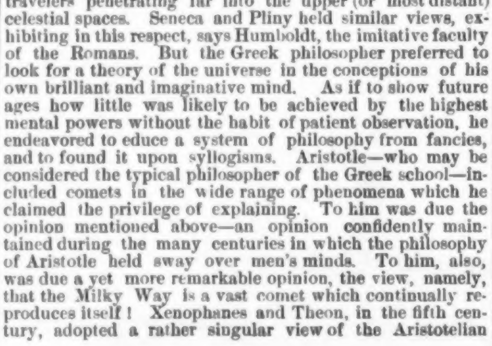


FIG. 2.—CHANGES OF A COMET WHEN FIRST SEEN.

To these fancies the ancients added the idea that the shapes of comets indicated their character as portents. Thus in Fig. 1 five views of comets are shown, as an arrow-head, a sea monster, a sword, a lance, and in flames.

Tycho Brahe was the first to express doubts respecting the views of Aristotle. From a careful series of observations, he demonstrated that the orbits of comets are certainly situated beyond the moon's orbit. He thought the orbits must be circular, for he lived at a time when none but circular orbits were conceded to the celestial bodies. Dörfel, a native of Upper Saxony, proved that the orbits of comets are either very elongated ovals, or parabolas, and that the sun occupies a focus of the curve. It happens, singularly enough, that this discovery was effected but a year or two before Newton propounded the theory of gravitation. Newton himself examined the orbit of the great comet of 1680 (known as "Newton's comet") and others; and he found that they all accord with the law of gravity.

But before long, Newton's friend and pupil, Halley, effected a yet more remarkable discovery. In hopes of confirming Newton's views by results founded on actual observation, he collected all the records of comets which seemed entitled to confidence, and attempted—as well as his meager materials would allow him—to calculate the elements of their orbits. In this way he computed the paths of no less than twenty-four. Among these, three presented a remarkable similarity. One appeared in 1531, and was described by Appian; another appeared in 1607, and was observed by Kepler; the third was traced by Halley himself in 1682. The equality of the intervals between these epochs led to the suspicion that the same comet had appeared three times. And Halley found, on searching historical records, that a comet appeared in 1305, another in 1380, and a third in 1456. Combining these appearances with those mentioned before, he thought he had satisfactory evidence of identity. For he was sufficiently familiar with the results which might be expected to flow from the law of gravity, to be aware that *absolute* regularity of motion was not to be expected in a body traversing the solar system in an eccentric orbit, and swayed from its proper path by the attraction of such giant planets as Jupiter and Saturn. Indeed it happens, singularly enough—one out of many remarkable coincidences in the history of comets—that the comet of 1380 was *not* Halley's comet, which really appeared in 1378, a date bringing in a yet greater discordance in the intervals than Halley had suspected and accounted for. With remarkable acumen—since no other means existed in his day for anything like accurate computation—he not only pointed out the possible influence of the great planets in disturbing the comet in past revolutions, but he made a rough approach to an estimate of the effect that they would have on the period of its next visit. "Instead of appearing in August, 1757, as it would if its period remained unaltered, it will not appear," he said, "until

FIG. 4.—COMET OF 1681 (*Newton's*).

the end of 1758, or the beginning of 1759, for it will be retarded by the action of Jupiter. Wherefore," he adds, with a pardonable anxiety to secure the credit of his ingenious investigations, "if it should return, according to our prediction, impartial posterity will not refuse to acknowledge that this was discovered by an Englishman."

As the time for the fulfillment of the prediction approached an intense interest was excited in the minds of astronomers. In 1757, Clairaut, Lalande, and Madame Lepaute undertook the computation of the epoch at which the comet might be expected to return. They applied methods of investigation invented by Clairaut himself. It resulted from their laborious computations that April 13, 1759, was fixed on for the epoch at which the comet should attain its closest approach to the sun, or, as it is technically expressed, should pass its perihelion. But Clairaut was careful to allow a month either way, on account of unavoidable omissions in the calculation and for the effects of unknown forces, "such as the action of some planet too far off to be seen" (a happy anticipation of modern discoveries).

And now the heavens were swept diligently by all the telescopists of Europe, each eager to be the first to announce the discovery of an object whose appearance or non-appearance was to confirm or to disprove the Newtonian theory. It was actually discovered, however, without telescopic aid, by a Saxon farmer, George Palitsch, on Christmas Day, 1758. It reached its perihelion on March 13, 1759, confirming at once the accuracy of Clairaut's computations, and the justice of his caution in assigning rather wide limits of error.

It was now evident that comets travel, like the planets, in determined paths; and also, that the investigation of their motions is a subject worthy the study of the ablest mathematicians, and sufficient to tax their highest powers. An account of their labors would be out of place in such an article as the present; but we recommend the subject to the notice of the agricultural student, as one of the most interesting chapters in the history of modern science.

One comet, however, discovered not long after astronomy had achieved this triumph, seemed at first to teach a different lesson. In 1770 a comet appeared whose path turned out to be—not a long oval or parabola, as had been the case with all the orbits yet examined—but an ellipse of moderate extent, and not very eccentric. The orbit lay also much closer than usual to that thin slice of space (so to speak) within which the planets are observed to move. Lexell, who computed the path, found that the period of the comet was about five and a half years. Its return was carefully watched for, *but no one has ever seen the comet since.* The cause of its disappearance, and also of its sudden appearance—for this was equally remarkable, when we remember that so conspicuous a comet could not have been circulating long in its small orbit without discovery—was carefully inquired into. The result was singular. On tracing back the path of the comet, it was found that it must have passed very near to the great planet Jupiter. "It had intruded," says Herschel, "an uninvited guest into his family circle—actually nearer to him than his fourth satellite." Accordingly, the comet's path, originally a long oval, had been bent into a curve of less extent. Having once entered on this new path, the comet was free to follow it—always returning, be it noticed, to the point at which it had started on it—so long as Jupiter was not interfered with. But it happened, unfortunately for the stability of the comet's motions, that, after going twice round the new path, it again presented itself near Jupiter's track, when the planet (which had meanwhile gone once round his orbit) was not very far from the scene of his former encounter. He accordingly again exerted his influence upon the unfortunate comet, and this time dismissed it on a path which will not admit of its approaching the earth near enough to be seen.*

Fig. 3.—THE COMET OF 1744 (*Cheseaux*).

Let us return, however, to Halley's comet.

It so chances that the comet which was the first to show full obedience to the law of gravitation was one which exhibited in a very remarkable and significant manner the characteristics which distinguish comets from other heavenly bodies, and make them so mysterious to the student of science. At the return of Halley's comet, in 1836, all that had signalized the return in 1759 was repeated, but the mathematical triumph was far greater. Damoiseau, Rosenberger, and Pontecoulant calculated the comet's return to perihelion within two or three days, instead of a month, and the time when it passed this point of its orbit corresponded, within a few hours, to the mean of their several estimates. On the northern heavens, when it was first seen, the comet presented a remarkable appearance, with a long and brilliant tail stretching over an arc of many degrees upon the sky. When it had passed from our northern skies, it was carried (after a short interval, during which it was lost to view in the sun's rays) to the southern heavens. Sir John Herschel and Maclear (Astronomer Royal at the Cape), were prepared to receive it; but when first observed by them it showed none of the features which made it so remarkable in our skies. It had no tail and scarcely any head. In fact, Sir John Herschel, in one account, says that as first seen it could only be distinguished from a fixed star by its motion.

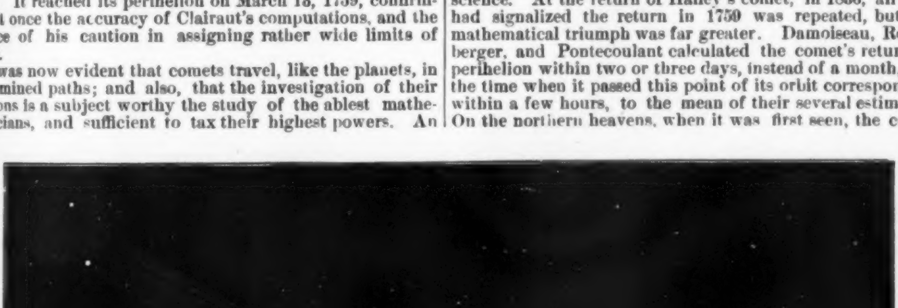


Fig. 5.—COMET OF 1843.

The study of its gradual change of aspect from that time threw so much light on the nature of comets' tails and other appendages (or at any rate of that particular comet's tail) that Sir John Herschel, not accustomed to be over confident, said there could be no doubt as to the true interpretation of the observed phenomena.

Most persons know that the name "comet" is derived from the word *coma*, or *hair*, and is applied to celestial objects which appear to have a hairy appendage. Modern astronomers do not, indeed, use the word *coma* in this sense, but draw a distinction between the *coma* and the tail. There can be no doubt, however, that the part now called the comet's tail was that from which these objects derived their name. The word *cometa* or *cometes* is not a lately-formed one; but was used by Cicero, Tibullus, and other ancient writers, and it is worthy of notice that all the names applied to comets by the Romans had a reference to *hairiness*—*stellæ comantes, crinitæ, concinnatæ*, they are called by Ovid, Pliny, and Cicero. The last term—signifying stars which show a *curled* or *crisped* hairiness—would not be very applicable, by the way, to any comets that have appeared in modern times. The Chinese applied to comets the name *sui*, or "broom."

It might be supposed that the hairy, broom-like, or tail-like appendage, so commonly seen in comets, is really a distinctive feature of these comets. This, however, is far from being the case. A very large number of comets have no visible tails. We refer, of course, principally to telescopic comets; for very few comets which have been conspicuous to the naked eye have wanted this appendage.

The *coma*—in the modern astronomical sense—is never wanting. This term is applied to a misty, hazy light, surrounding on every side a small bright spot, which is termed the *nucleus* of the comet.

When first seen in the telescope, a comet usually presents a small round disk of hazy light, somewhat brighter near the center. As the comet approaches the sun, the disk lengthens, and, if the comet is to be a tailed one, traces begin to be seen of a streakiness in the comet's light. Gradually a tail is formed, which is turned always *from* the sun (Fig. 2). The tail grows brighter and longer, and the head becomes developed into a coma surrounding a distinctly-marked nucleus. Presently the comet is lost to view through its near approach to the sun. But after awhile it is again seen, sometimes wonderfully changed in aspect through the effects of solar heat. Some comets are brighter and more striking after passing their point of nearest approach to the sun (or *perihelion*) than before; others are quite shorn of their splendor when they reappear. The latter was the case with the comet of 1835-36, as we have already seen. On the other hand, the comet of 1861 burst upon us in its full splendor *after perihelion* passage.

Some comets have more than one tail. One appeared in 1744 which had no less than six tails, symmetrically disposed (if one can trust the pictures handed down to us) in the figure of a half-opened fan (Fig. 3). Others have presented a yet more peculiar appearance, having, besides a tail in the usual position, a second "uncomformable" tail, at right angles to the first, or inclined to it at some incongruous, out-of-the way angle—for instance, in one case, one hundred and sixty degrees. Sometimes the peculiarity is presented of a perfectly dark gap separating the tail from the head. More commonly a dark space is seen behind the head, but on each side of this space the light from the head is continued so as to form a bright border on each side of the tail.

As a comet approaches the sun we have seen that a change takes place in the appearance of the coma and nucleus, and that in some instances a tail is generated. The process actually observed is generally this: in the forward part of the nucleus a turbulent action is seen to be in progress, leading to the propulsion toward the sun of jets of streams of misty-looking matter. Sometimes a regular cap or envelope is seen to be projected in this manner toward the sun, or even a set of envelopes one within the other. The matter thus thrown off is not suffered to pass very far from the nucleus toward the sun, but is swept away, as fast as formed, in the contrary direction. If the funnel of a steam engine were directed forward, instead of upward, then the appearance presented by the emitted steam, as the engine rushed on (against a hurricane, suppose, to make the illustration more perfect) would exemplify the process which seems to be taking place around the front of the nucleus, and far behind it as the matter formed is continually swept away *from* the sun. The same sun which attracts the nucleus seems to repulse the emitted matter with inconceivable energy. Consider for a moment what took place with Newton's comet in 1680-81 (Fig. 4). When this comet was about as far off from the sun as our earth (ninety million miles) it began to throw out a tail. But the comet was going far nearer to the sun than this. Onward it rushed under the powerful influence of the sun's attraction, until it had crossed the whole space of ninety million miles, making—almost in a straight line—for a point only one hundred and thirty thousand miles from the sun's surface. In four weeks it traversed that vast distance, and then, suddenly (in a few hours) sweeping half round the sun, started on its return journey. But note this: as it approached the sun, the comet had thrown out a tail continually increasing in length, and pointing *back* almost along the orbit; then the comet is lost to sight for a few days, and when it is next seen returning rapidly from the sun, it has a tail pointing *forwards* (a tail which *must* be a different one, since—as Herschel says—"we cannot conceive a comet's tail to be brandished round like a stick") and ninety million miles in length. So that, whereas the comet, already moving with a tremendous acquired velocity, had taken four weeks in traversing a distance of ninety millions of miles under the sun's *attraction*, the matter composing the tail had been thrown to the same enormous distance by the sun's *repulsion* in scarcely one-tenth part of the time, possibly (for the tail was formed when first seen) in a few hours!

The comet of 1843 (Fig. 5) was yet more remarkable for the dimensions of its tail and for its close approach to the sun. The tail of this comet stretched half way across the sky in March, 1843. Its real length was two hundred million miles *at least*, for the end of the tail was lost to view through the excessive faintness of its light. So near did this comet pass to the sun, that many astronomers did not expect ever to see the comet again. But—after all but grazing the sun—sweeping round him at a distance of less than one-tenth of his diameter, the comet escaped and passed back again into space.

When we see the tail of a comet occupying a volume thousands of times greater than that of the sun itself, the question naturally suggests itself, "How does it happen that so vast a body can sweep through the solar system without deranging the motion of every planet?" Conceding even an extreme tenuity to the substance composing so vast a vol-

* It must be noticed, however, that Leverrier, who very carefully re-examined the question, was led to question the accuracy of the results recorded above. Admitting that Jupiter had twice disturbed the comet, he thinks there is no certainty (for want of sufficiently accurate observations) respecting either the original path of the comet, or that in which it is at present circulating unobserved—if, indeed, it has not been *absorbed* by Jupiter.

ume, one would still expect its mass to be tremendous. For instance, if we supposed the whole mass of the tail of the comet of 1843 to consist of hydrogen gas (the lightest substance known to us), yet even then the mass of the tail would have largely exceeded that of the sun. Every planet would have been dragged from its orbit by so vast a mass passing so near. We know, on the contrary, that no such effects were produced. The length of our year did not change by a single second, showing that our earth had been neither hastened nor retarded in its steady motion round the sun. Thus we are forced to admit that the actual substance of the comet was inconceivably rare. A jarful of air would probably have outweighed hundreds of cubic miles of that vast appendage which blazed across our skies, to the terror of the ignorant and superstitious.

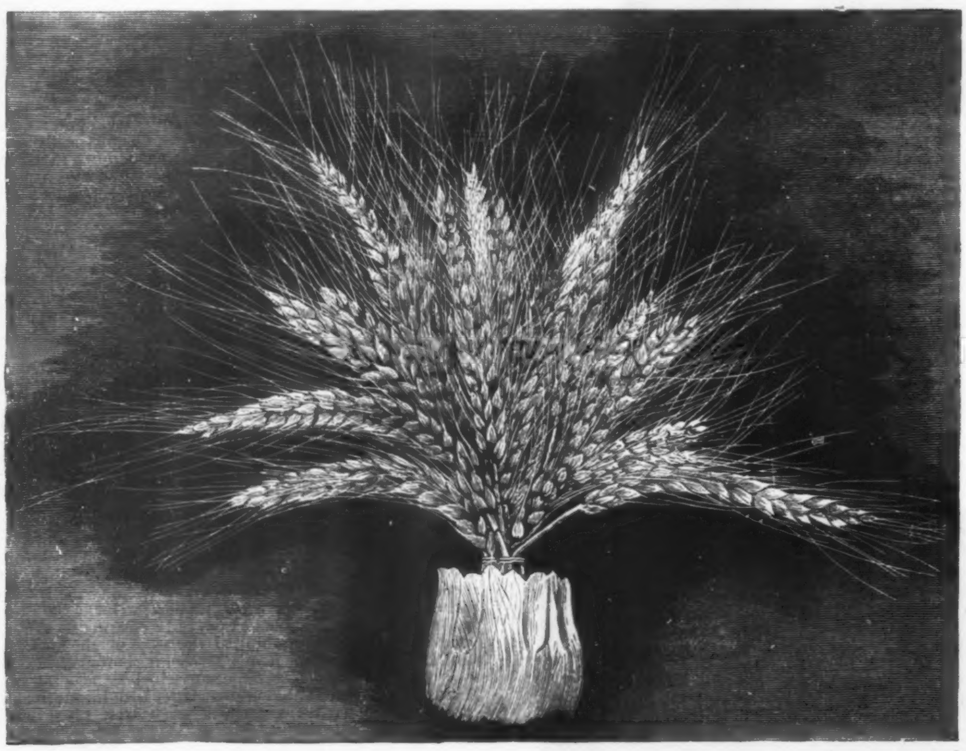
The dread of the possible evils which might accrue if the earth encountered a comet will possibly be diminished by the consideration of the extreme tenuity of these objects. But the feeling may still remain that influences, other than those due to mere weight or mass, might be exerted upon terrestrial races in the course of such an encounter. The subtle breath of some mephitic vapor might penetrate our atmosphere, and, if it did not bring immediate destruction, might leave dire forms of plague and pestilence to work their evil will upon the human race. This fear is not, perhaps, wholly unreasonable, though—as will presently appear—the positive information we now have does *not* favor the supposition that the tail, at any rate, of a comet, is likely to exercise such destructive effects. And it is only the tails of comets that we have much chance of meeting. On account of their enormous volumes, it is not so utterly improbable that we should encounter them as that we should meet the comparatively minute nuclei. In fact, there is reason for supposing that the earth actually did pass through the tail of the comet of 1861. At about the hour when it was calculated that the encounter should have taken place, a strange *auroral glare* was seen in the atmosphere, but beyond this no effect was perceptible.

(*To be continued.*)

CHAMPLAIN'S BEARDED WHEAT.

THIS is a red-bearded wheat, with white chaff, free from rust and smut, yielding a lighter colored grain than usual, which makes a flour of superior quality. Its strong and vigorous straw stands erect, frequently bearing, even in very ordinary culture, heads from five to six inches in length, containing from sixty to seventy-five kernels each. So says Mr. A. A. Dunnicliff, of Burrawang, near Sutton Forest, to whom we must give the credit of having introduced this wheat into this colony. Mr. Dunnicliff does not assert that it is rust-proof, but after several years' cultivation it has that reputation, and has, under particularly adverse circumstances, withstood all his efforts to develop rust or smut on stalk, flag, or head. He has been a close observer of the conditions of these diseases in these colonies for the last five and twenty years. Mr. Dunnicliff has grown 791 pounds of this wheat from one pound of seed. In 1878, under great hardships, the Champlain wheat matured, on Mr. Dunnicliff's farm, 46½ bushels per acre in fourteen weeks and a half; while other varieties, excepting Defiance, were not worth harvesting. The trials in 1879, a thoroughly rusty season, were more severe, comprehensive, and complete, resulting in clean sweet straw and bold sound grains.

Mr. Arthur T. Holroyd, in company with Mr. Edward Carter, of Sutton Forest, visited Mr. Dunnicliff's farm in January, 1880, and there saw crops of Champlain's and Defiance wheats, which were beautifully clean and free from rust or any other disease, while other wheats, such as White, Nonpareil, Tuscan, Wold's Pedigree, and other varieties, growing under precisely similar conditions, and in the immediate neighborhood of the former, were completely destroyed with rust. Some time ago Mr. Holroyd had for several successive years grown a few acres of wheat on his farm at Sherwood Scrubs first on virgin soil recently cleared; then on pipe-drained land; and, lastly, on land treated with salt, when the plants were four or five inches in height, and in every instance the crops were destroyed by rust. Being much surprised at the result of Mr. Dunnicliff's success, he determined, last autumn, to try Champlain's Bearded Wheat and Defiance at the Scrubs. He procured a peck of half of each from him, and sowed them on a quarter of an acre, in a three-acre paddock in which was a crop of oats for hay on the south side. The ground was liberally manured with bone-dust from the Sydney Meat Preserving Company, and the crop astonished him and his agricultural friends. The straw was between five and six feet high—single grains shooted, in many instances, to thirty straws, and yielded a crop of grain equivalent to twelve hundred-fold. There were patches of rust on the oats close to the wheat, but not a trace of it on the straw or grain. The yield of the two samples will be, it is expected, between seven and eight bushels. Mr. Holroyd will continue his experiments next autumn, and, if he steers clear of rust then, Mr. Dunnicliff will be hailed among Cumberland farmers as the greatest benefactor we have had for many years. The engraving of the Champlain Bearded Wheat was from a sample grown by Mr. Holroyd, and is from a photograph.—*Illustrated Sydney News.*



CHAMPLAIN'S BEARDED WHEAT.

RUSSIAN HILLS OF PETROLEUM.

A FORMER operator of the McKean district, who some time ago went to Russia for the purpose of assisting in the work of developing the oil field in the southern part of the Crimea, writes regarding the field as follows: "Am located fifteen miles from the city of Kertch, and am in the employ of the Petroleum Oil Company of Paris, France. We located the first well, and commenced business soon after our arrival last fall. We drove five different kinds of pipe before we reached bed-rock at 300 feet. The first was fifteen inches in diameter, the second twelve inches, the third ten inches, the fourth eight inches, and the fifth six inches. These were driven through a tough clay, very much like putty in consistency. As soon as this clay gets wet it caves and packs around the pipe to such an extent that it is impossible to drive the pipe through it. This is the reason for using so many different sizes of pipe, as the smaller is driven inside of the larger as soon as the latter ceases to move downward. We had to move the rig twice on account of crooked holes. This was done without tearing it down, and it was moved 400 feet each time. The wells are now abandoned, as the pipe will go no further, and solid rock has not yet been reached. The driver or ram weighs 2,200 pounds, and is dropped ten feet every time. It is easily understood, therefore, what a pressure there exists against the pipe. It sometimes requires twelve strokes to drive it one inch. About half a barrel of oil was taken out of the clay per day. The natives bore with a pod auger 30 or 40 feet, and bail out about one half barrel of oil a day, which is worth in the city of Kertch about $5.00.

"One of the curiosities of this country is a hill of petroleum, which the company proposes shipping to Paris. This company is very wealthy, having a capital of $3,000,000. It has $38,000 invested in oil-well supplies in the city of Kertch alone. It has seven ships on the Black Sea, and expect that there will be one thousand shiploads of the petroleum hill. This hill is composed of a mixture of clay and oil. They are formed by boiling springs, which abound all over this part of the country. They boil up out of the level ground, and form a kind of hill. The water runs away, leaving an argillaceous mound, and when the spring becomes extinct the hill of petroleum remains. The company proposes reducing the material, at Paris, to an article of commerce. It claims that it can manufacture a good article of illuminating oil from this raw material; also asphaltum.

"The occupation of the people around Kertch is stock-raising, and they live in villages. The hair of the natives all turn gray at the age of thirty. The hair becomes perfectly white, and such a thing as a dentist is not known in the country. Everybody's teeth are sound. There are no trees in this country except those planted out, but vegetation is very luxuriant. As an oil field, it therefore contrasts strongly with Pennsylvania."

A LARGE TUMOR.—At the Hospital of the University of Pennsylvania, February 10, Dr. William Goodall removed an ovarian tumor weighing 112 pounds. The patient 31 years of age, weighed only 75 pounds after the operation. The doctor naively remarked that he had taken the woman from the tumor. There was a fair prospect that the patient would survive the operation.

THE CALIFORNIA OIL FIELD.

A THOROUGHLY posted correspondent of the *Age* writes from the oil field of California as follows:

"At the present time the daily yield of oil in this State is about 300 barrels. Of this 250 barrels are produced in Los Angeles county and 50 barrels in Santa Clara county. The oil is about 41° gravity, and is rather richer in carbon than the oils found in Pennsylvania. In lower California the oil produced may be said to have no paraffine as a constituent part; while in the upper or Santa Clara district paraffine forms a conspicuous percentage.

"The wells range in depth from 500 to 1,500 feet, but the depth does not depend so much upon the elevation at the surface as upon the location of the well in regard to the dip of the rock, the rock standing at an angle of 45 degrees.

"The oil is transported entirely by the Continental Oil and Transportation Company, and is manufactured by the Pacific Coast Oil Company.

"California and the Pacific Coast States consume about 5,000,000 gallons of refined per annum; and otherwise use 1,000,000 barrels of crude. Of course what is not produced is transported by the above company from the eastern manufactories."

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